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DEPARTMENT TECHNICAL MANUAL

TM 5-276

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TEN-TON TRESTLE BRIDGE

WAR DEPARTMENT · 19 OCTOBER 1943

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1943

TECHNICAL MANUAL

TEN-TON TRESTLE BRIDGE

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D. C., 11 April 1944.

TM 5–276, 19 October 1943, is changed as follows:

3. COMPOSITION AND ISSUE a. (Superseded.) One unit provides 75 feet of normal bridge or 45 feet of reinforced bridge. The principal components of one unit are four 10-ton trestles, 50 trestle balk, seventy-five 10-ton ponton chess, and 10-ton trestle bracing. (See app.)

* * * * * * *

13. TRANSPORTATION (Superseded) **a. General.** One unit of 10-ton trestle bridge can be transported by two 2½-ton cargo trucks and two 2-wheel pole-type trailers or two 4-ton ponton trucks and two 2-wheel pole-type trailers.

b. Prime mover for two-wheel trailer. The prime mover is either a 2½-ton long wheel-base cargo truck with a 12-foot loading bed or a 4-ton ponton truck with a 12-foot, 3-inch loading bed. The 2½-ton short heel-base cargo truck with a 9-foot loading bed cannot be used since the overhang of the load would interfere with the trailed load.

c. Two-wheel trailer. (1) The two-wheel pole-type trailer, type II, with pneumatic tires, has a rectangular frame with a drawbar of adjustable length. The drawbar is telescopic, permitting three adjustments in lengths. A rest supports it horizontally when the trailer is unhooked from the prime mover.

(2) A load is made fast to the trailer by clamping beams held in position with hand-operated screws and chain links. When the trailer is not loaded, the clamping beams are held in brackets especially provided for that purpose.

(3) The empty trailer, with a spare tire, weighs about 2,300 pounds.

14. LOADING (Superseded) **a. General.** The 2½-ton trucks are loaded in the same manner as the 4-ton trucks, and all trailers are loaded identically. One truck and trailer load provides equipment for one abutment span and one and one-half trestle spans. The combined loads provide equipment for a complete bridge 75 feet long (five spans).

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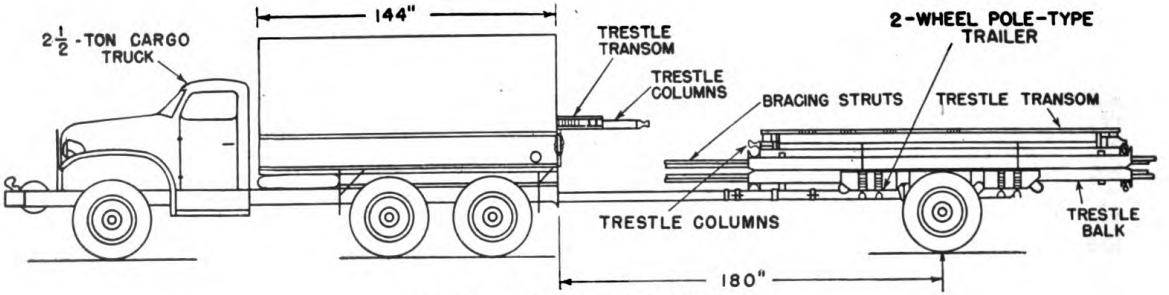

TRUCK AND TRAILER LOADING

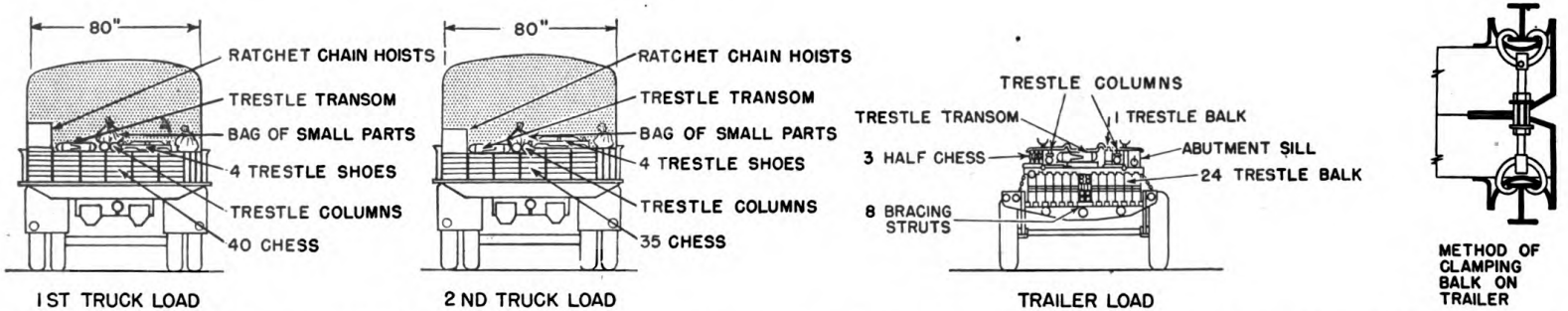

Figure 18. Loading 10-ton trestle-bridge equipment on 2½-ton cargo truck and two-wheel trailer. (A 4-ton truck may be used in place of the 2½-ton truck, and is loaded in exactly the same manner.)

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b. For detailed loading of two-wheel trailer see figure 18 and the following table:

TRAILER LOADINGS

Item	Trailer		Total
	1	2	
Balk, trestle, 10-ton	25	25	50
Chess, ponton half, 10-ton	3	3	6
Sill, abutment, 10-ton	1	1	2
Strut, bracing	8	8	16
Trestle, without hoist and shoes	1	1	2

c. For detailed loading of prime mover see figure 18 and the following table:

TRUCK LOADINGS

Item	Truck		Total
	1	2	
Auger, post hole, 6-inch capacity	1	0	1
Bolt, clamp, trestle, 10-ton	3	3	6
Chess, ponton, 10-ton	35	40	75
Clamp, column-bracing, 10-ton	16	16	32
Clamp, siderail, ponton, 10-ton	15	15	30
Clip, wire-rope, ½-inch	12	12	24
Grip, wire-rope, ½-inch	1	1	2
Handle, clamp, trestle, 10-ton	3	3	6
Hoist, chain, ratchet, 1½- to 3-ton, two hoists in chest	2	2	4
Holdfast, complete with nine pickets	1	1	2
Nut, clamp, trestle, 10-ton	3	3	6
Picket, steel, 1¼- by 36-inch	8	8	16
Pin, lifting trestle, 10-ton, with chain	3	3	6
Pin, strut-shoe	8	8	16
Post, anchor, 10-ton	2	2	4
Shoe, bracing-strut	8	8	16
Shoe, trestle, 10-ton	4	4	8
Trestle, 10-ton, without hoists and shoes	1	1	2

d. Loading Equipage. All of the equipage of the 10-ton trestle bridge can be loaded on the trucks and trailers by hand.

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20. TRESTLES a. Shallow-Water Trestles.

* * * * * * *

(3) (Added) *Assembly of M2 trestle.* Because of the shape of the M2 trestle and the position of the pinholes, it is difficult to assemble by the method described in a(1)(*a*) above. Two trestle balk lying one on top of the other are placed perpendicular to the shore line. Two more trestle balk are similarly placed approximately 12 feet from the first pair. Then the transom is placed across the balk (fig. 21.1) and the trestle columns inserted. After erection, the four balk may be used in constructing the approach span.

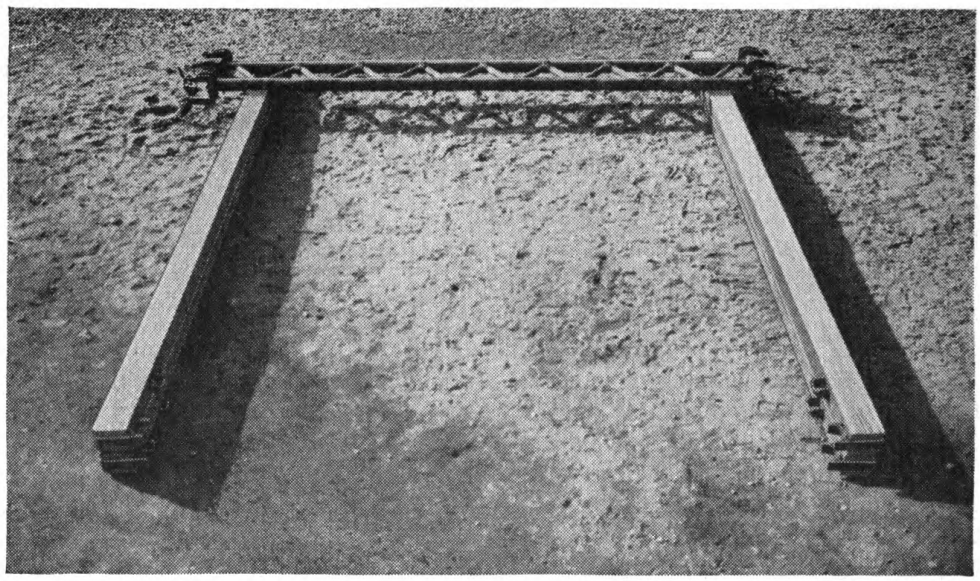

Figure 21.1. Positions of trestle balk and transom for assembly of M2 trestle.

b. Deep-Water Trestles.

* * * * * * *

(3) (Added) *Alternate method of holding trestle columns.* A trestle bracing clamp can be used instead of a rope lashing to hold the trestle column until the trestle is aligned. The clamp is placed with the handle in a convenient position for rapid loosening. (See fig. 27.1.) When the trestle is aligned, one turn of the handle is sufficient to release the trestle column and permit it to slide into the water.

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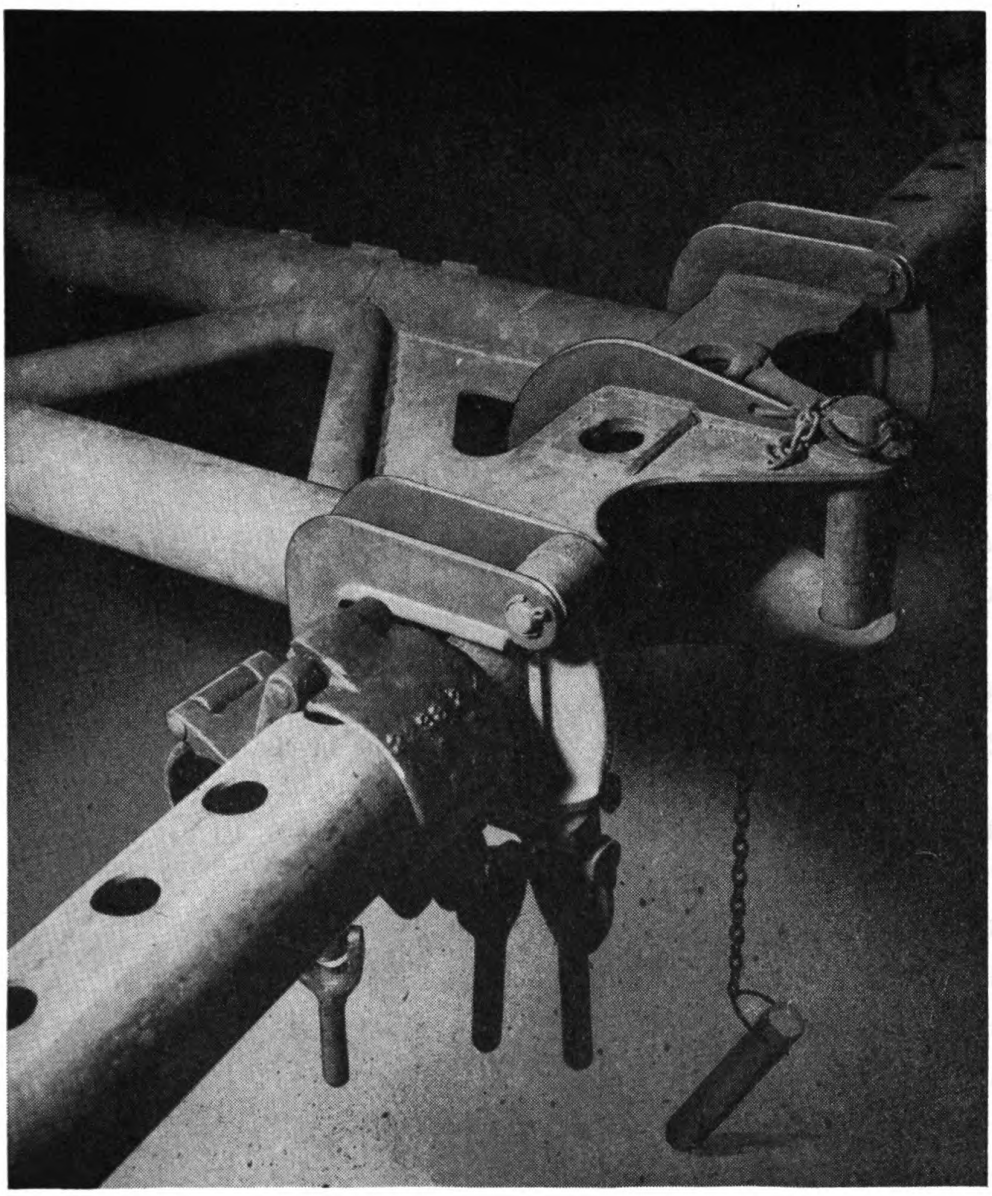

Figure 27.1. Method of holding trestle column with trestle bracing clamp in erection of deep-water trestle.

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APPENDIX (Superseded)

LIST OF TEN-TON TRESTLE EQUIPMENT

Item	*Quantity*
Auger, post hole, 6-inch capacity	1
Balk, trestle, 10-ton	50
Bolt, clamp, trestle, 10-ton	6
Chess, ponton, 10-ton	75
Chess, ponton half, 10-ton	6
Clamp, column-bracing, 10-ton	32
Clamp, siderail, ponton, 10-ton	30
Clip, wire-rope, ½-inch	24
Grip, wire-rope, ½-inch	2
Handle, clamp, trestle, 10-ton	6
Hoist, chain, ratchet, 1½- to 3-ton, two hoists in chest with spare parts	4
Holdfast, complete with nine pickets	2
Nut, clamp, trestle, 10-ton	6
Picket, steel, 1¼- by 36-inch	16
Pin, lifting, trestle, 10-ton, with chain	6
Pin, strut-shoe	16
Post, anchor, 10-ton	4
Shoe, bracing-strut	16
Sill, abutment, 10-ton	2
Strut, bracing	16
Trestle, 10-ton, complete without hoists	4

[A. G. 300.7 (23 Feb 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1944

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WAR DEPARTMENT TECHNICAL MANUAL

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TEN-TON TRESTLE BRIDGE

WAR DEPARTMENT · 19 OCTOBER 1943

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WAR DEPARTMENT,

WASHINGTON 25, D. C., 19 October 1943.

TM 5–276, Ten-Ton Trestle Bridge, is published for the information and guidance of all concerned.

[A. G. 300.7 (24 May 43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
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The Adjutant General.

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(For explanation of symbols see FM 21–6.)

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TEN-TON TRESTLE BRIDGE

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SECTION I

GENERAL

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1. PURPOSE. The 10-ton trestle bridge (fig. 1) is a portable fixed bridge. It is suitable for crossing infantry division loads over dry gaps, or over a shallow stream the bed of which is less than 12 feet below the deck.

Figure 1. Ten-ton trestle bridge

2. GENERAL DESIGN a. The bridge consists of 10-ton trestle balk and chess supported on 10-ton trestles. Trestle bracing makes the bridge more stable.

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b. In normal construction there are eight balk per span, not including siderails. The bridge is reinforced by adding six balk to each span.

c. Each span is 15 feet long. Clear width of the roadway is 9 feet 10 inches.

3. COMPOSITION AND ISSUE a. One unit provides 75 feet of bridge, normal or reinforced. The principal components of one unit are four 10-ton trestles, eighty trestle balk, eighty 10-ton ponton chess, and 10-ton trestle bracing. (See app.)

b. Units of the bridge are stocked in general depots for issue as determined by the theater of operations commander.

4. CAPACITY a. Trestle bridge used as a fixed bridge. Posted and vehicle capacities are given in table I.

b. Trestle bridge used in combination with floating bridge. Capacities of the floating bridge govern. These capacities vary with the stream velocity. (See FM 5–10.)

5. WORKING PARTY AND TIME REQUIRED. Under favorable conditions a platoon can construct 75 feet of 10-ton trestle bridge in about 1½ hours at a prepared site. Darkness, tired or inexperienced personnel, poor weather, poor construction site, or enemy activity increases the time required. A suggested working party organization is given in section VI.

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VEHICLE	GROSS WT-TONS	10-TON TRESTLE BRIDGE	
		NORMAL ① 8 BALK	REINFORCED 14 BALK ①
		POSTED CAPACITY—TONS	
		12	18
Truck, 2½-T, w/105-mm How.	10		
Truck, 2½-T, w/1-T tlr.	10		
Sterilizer unit (Medical)	10		
Tractor, D-4, w/dozer	7		
Grader, road, mtzd. (Engr.)	11		
Truck, 4-T, wrecker	11		
Truck, 2½-T, w/155-mm How., carr. M1	14		
Trk-tractor, 4-5T, w/semi-tlr., fuel serv., F-2 (AC)	15		
Trk-tractor, 5-6T, w/ semi-tlr., ponton	18		
H-10 loading (AASHO)			
Truck, 2½-T, w/8-T tlr.	21		
Truck, 4-T, cargo (same as distributor, water)	13		
Truck, 4-T, ponton	13		
Truck, 4-T, w/155-mm How., carr. M1	19		
Crane, trk-mtd. (Engr.)	12		
Crane, trk-mtd., w/crane atchmnts. tlr.	18		
Tank, light, M2A4	12		
Truck, 4-T, cargo, w/8-T tlr.	26		
Truck, wrecking, C-1 (AC)	16		
Tank, light, M3	14		
Truck, 6-T, cargo	18		
Truck, 6-T, bridge	19		
Truck, 6-T, w/90-mm AA, M1	26		
Truck, 6-T, w/3-in. AA, M2A2	26		
Truck, 6-T, w/distributor, bituminous, 1,250-gal.	28		
Tank, light, M5	16		
H-15 loading			
Tractor, D-7, w/dozer	15		
Motor carriage, M8	16		
Trk-tractor, 6-T, w/semi-tlr., wrecking, C-2	33		
Truck, 7½-T, cargo & prime mover	21		
Tank, light, 18-T	18		
Tank, medium, M2A1	21		
Trk-tractor, 7½-T, w/semi-tlr., fuel serv., F-1 (AC)	30		
Truck, 6-T, w/16-T tlr	39		
Truck, 7½-T, w/155-mm gun, carr. M2 & M3	34		
Truck, 7½-T, w/8-in. gun, carr. M2, transp M1	45		
H-20 loading			
Truck, 6-T, w/20-T tlr.	45		
Trk-tractor, 5-6T, w/ 20-T semi-tlr.	37		
Truck, 7½-T, w/20-T tlr.	49		
Motor carriage, M7	24		
Tractor, D-8, w/dozer	22		
Motor carriage, M12	27		
Motor carriage, M10	29		

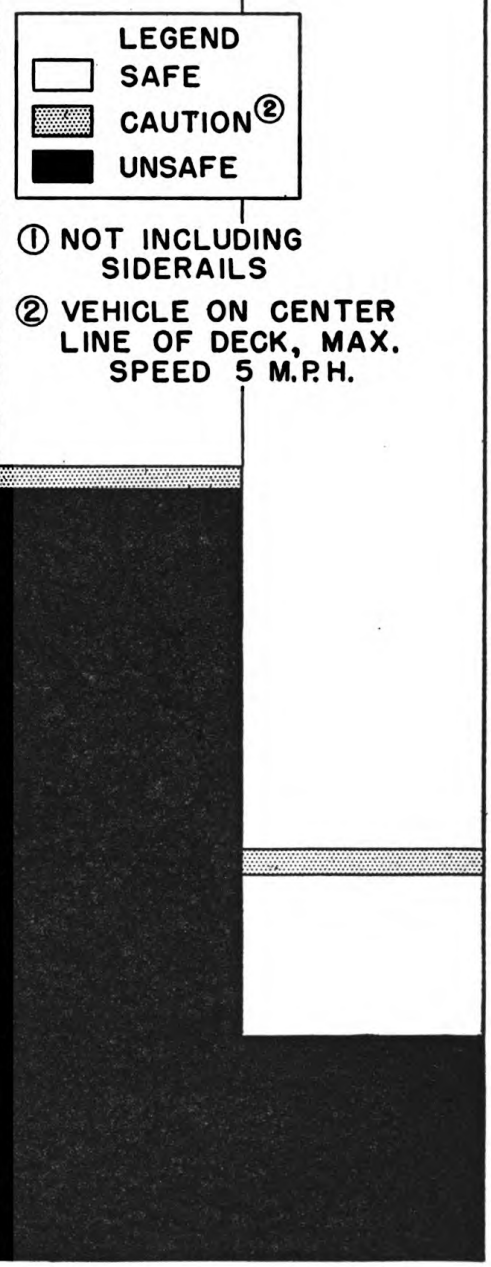

TABLE I. *Posted and vehicle capacities of 10-ton trestle bridge (tentative, pending further tests)*

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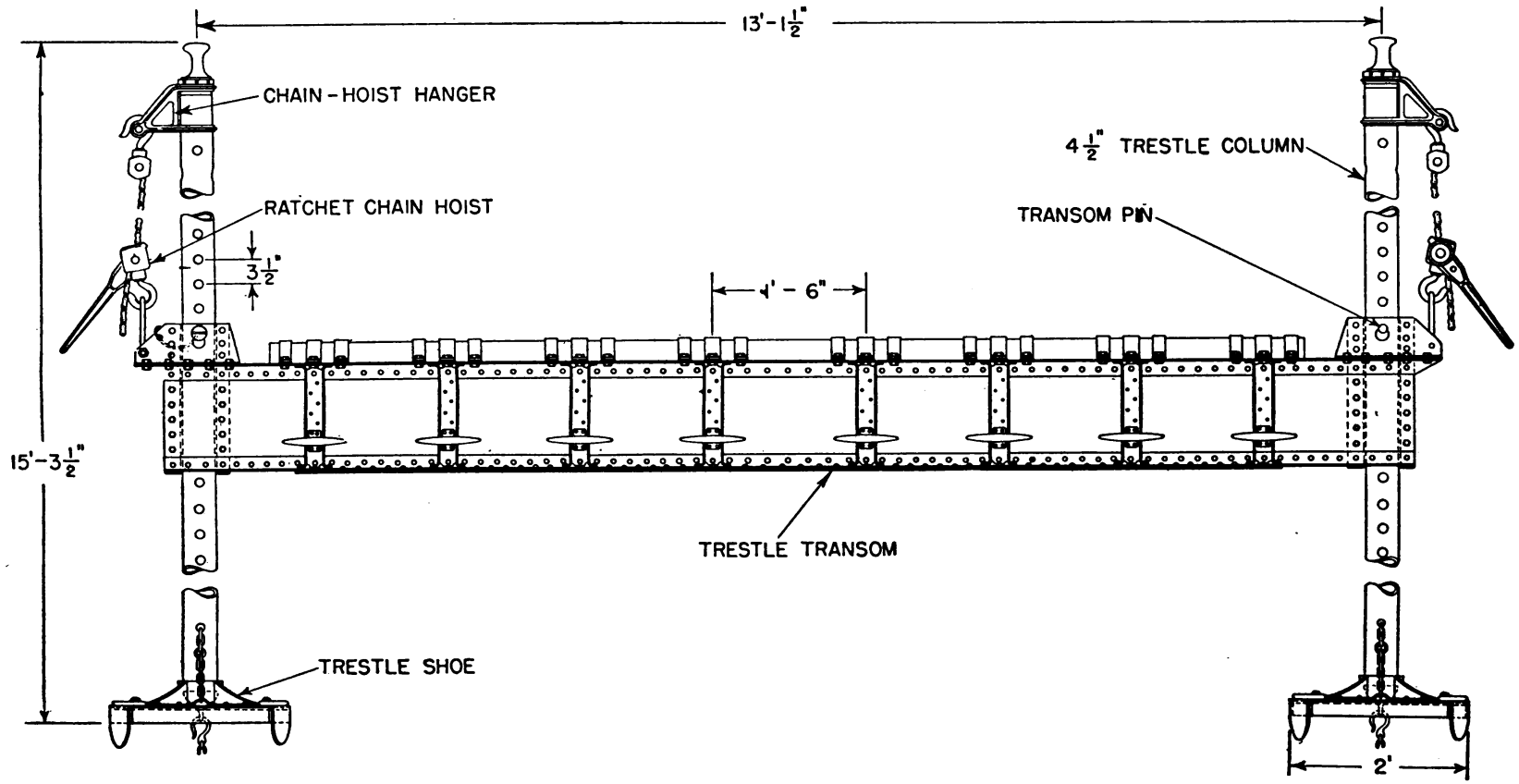

Figure 2. Ten-ton trestle M1

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SECTION II

DESCRIPTION OF EQUIPMENT

---

6. TRESTLES a. 10-ton trestle M1. (1) The 10-ton trestle M1 (aluminum) consists of a transom, two columns, and two shoes. Two ratchet chain hoists are used to adjust the height of the transom. The assembled trestle, less chain hoists, weighs 750 pounds. It is 15 feet 3 inches high and 13 feet 1½ inches wide from center to center of columns. Maximum overhead clearance is 12 feet. (See fig. 2.)

(2) *Trestle transom M1.* The trestle transom M1 is a built-up alloy beam, 13 feet 10 inches long, 9 inches wide, and 15 inches deep. A steel tube attached to its top supports the end fittings of trestle balk. Metal fittings on the tube fix the position of the 8 pairs of trestle balk used in the normal bridge. Two extra balk will fit in each interval between attachments, so that a maximum of 15 pairs of balk per span can be used in a reinforced bridge. Cleats are provided on the transom for lashing down the trestle balk.

(3) *Trestle column M1.* Trestle columns M1 are aluminum alloy tubes 4½ inches in diameter. They are inserted through wells in each end of the transom M1 and secured in place by pins chained to each end of the transom. A vertical row of holes, on 3½-inch centers, is drilled through each column. Two horizontal pin holes, spaced 1¾ inches vertically, are drilled perpendicular to each other through each column well of the transom. Each end of the transom is held in place on the column by a pin through one of the two holes in the column well and a hole in the column. (See fig. 3.) A 3½-inch adjustment in transom height is made by insterting the pin in another hole on the column without changing holes in the transom. A 1¾-inch adjustment is made by rotating the column through 90° and using the other hole in the transom.

A spool on top of the column permits attachment of guy lines. Below the spool is a swiveled hanger to which the ratchet chain hoist is attached.

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Figure 3. Pin being inserted in transom and column

(4) *Trestle shoe M1.* The trestle shoe M1 is a metal footing 24 inches square. It is attached to the bottom of each trestle column by a ball-and-socket joint to permit free movement of the shoe about the end of the column, and is secured to the column by two hooks chained to the shoe. One hook engages a pair of holes in the column and the other engages an eye on the end of the column.

(5) *Ratchet chain hoists.* (*a*) Two 1½- to 3-ton ratchet chain hoists are used to adjust the height of the trestle transom. This type of hoist (fig. 4) is used with both the trestle M1 and the trestle M2, and supplants the 1-ton differential chain hoist. It has a 12-foot chain which can be attached so that only a single strand of chain takes the load (capacity 1½ tons), or so that two strands of chain take the load (capacity 3 tons). For use with 10-ton trestles, the single-chain connection is used, giving the full effective length of 12 feet.

(*b*) One hook of the ratchet chain hoist is attached to the swiveled hanger at the top of the column M1, or to the chain-hoist bracket on the column M2, and the other hook to the stirrup at the end of transom M1, or to the pin at the end of the transom M2. To adjust the height of the transom, attach a hoist on each column, remove transom pins, adjust height of transom to desired level actuating both hoists at the same time, reinsert pins, and remove hoists. The hoists are not designed to take the heavy loads of the bridge; therefore, they must be removed or disengaged, with the transom pins in place, before any load goes on the bridge.

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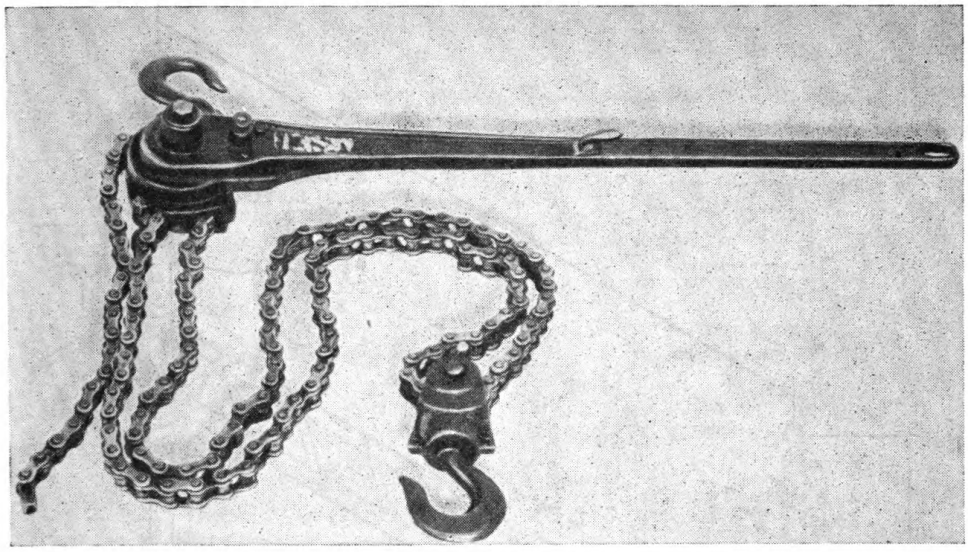

Figure 4. Ratchet chain hoist, 1½- to 3-ton

(*c*) A ratchet chain hoist weighs about 38 pounds. Two chain hoists are carried with spare parts in a chest. Ratchet chain hoists are also used to tighten trestle shoe anchor lines.

b. 10-ton trestle M2. (1) The 10-ton trestle M2 (steel) is an all-steel trestle similar in general design and dimensions to the aluminum trestle M1. The weight of the assembled trestle is about the same as the weight of the trestle M1. The trestle is described only as it differs from the trestle M1. (See fig. 5.)

(2) *Trestle transom M2.* (*a*) This transom consists of a tubular steel truss section, 13 feet 10 inches long and 19 inches deep. The tube is 3½ inches in diameter. There is no column well at each end; instead, each end is open, so that the trestle column can be inserted from the side. Two metal clamps keep the jaws of this opening together.

(*b*) At each end of the transom are three sets of pin holes, and two pins chained to the transom. To one pin, inserted in the outermost set of pin holes, is attached the lower end of the ratchet chain hoist. The second pin is inserted through one or the other of the two remaining sets of holes and through one of the holes in the trestle column, thus fastening the transom to the column. The latter two sets of holes are spaced 5¼ inches apart vertically, and, since the holes on the trestle column are spaced 3½ inches apart, a 1¾-inch adjustment can be made.

(3) *Trestle column M2.* The vertical row of holes in the column M2 extends to the top of the column. The swiveled hanger on top of the column is eliminated. In its place is substituted a detachable chain-hoist supporting bracket described below.

(4) *Trestle shoe M2.* This shoe is made of steel and is 27 inches square.

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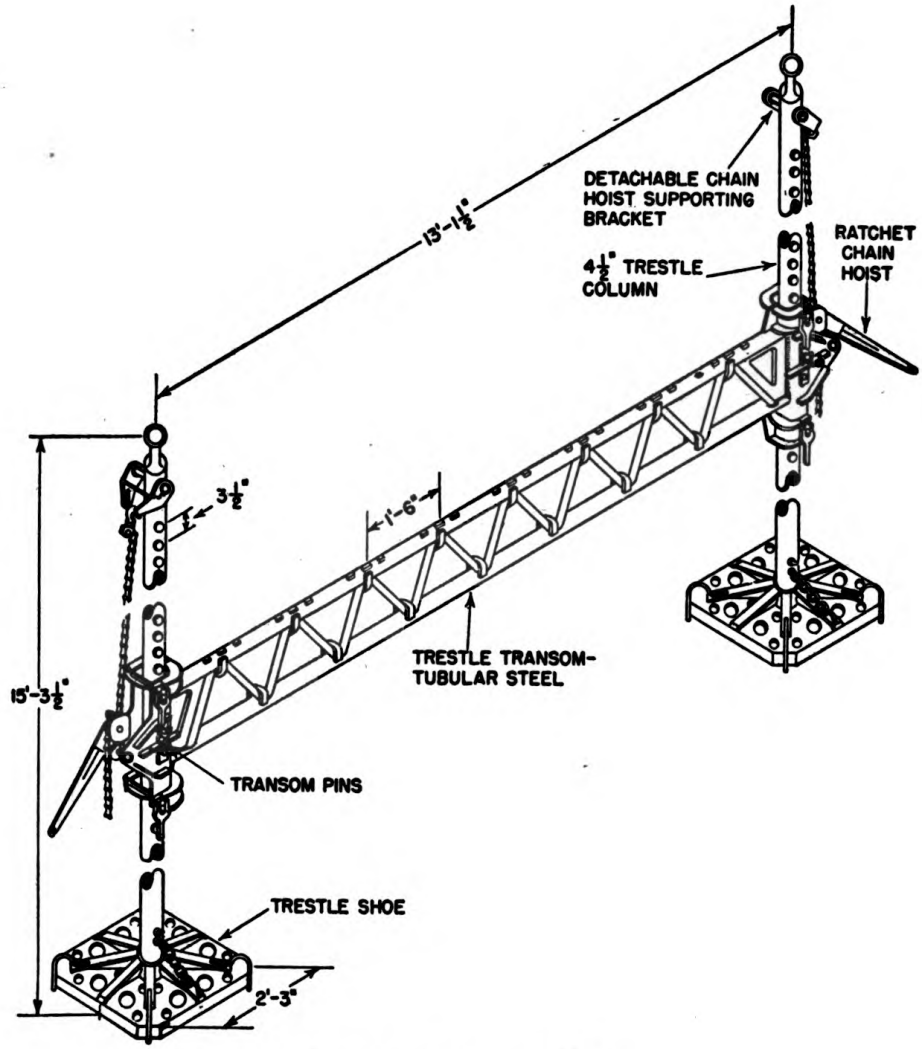

Figure 5. Ten-ton trestle M2

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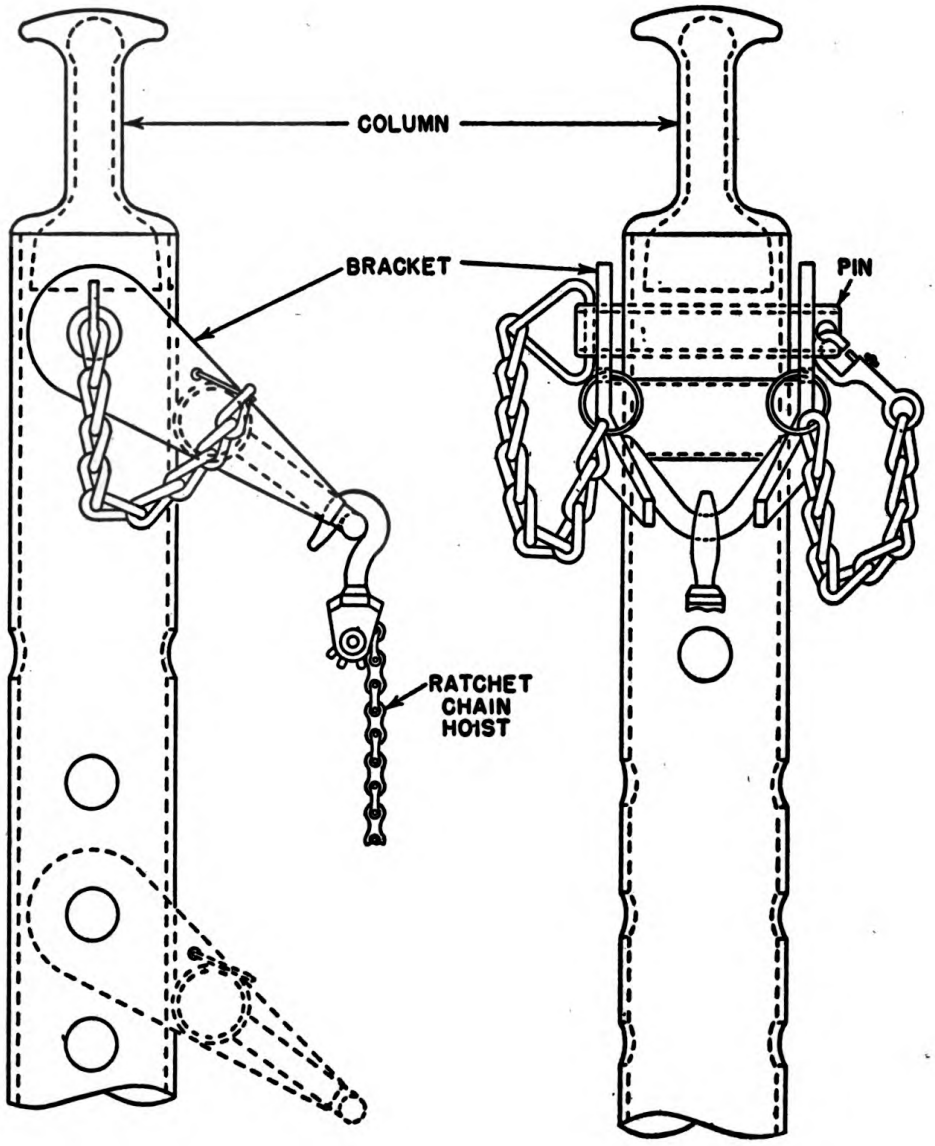

Figure 6. Detachable chain-hoist supporting bracket

(5) *Chain-hoist supporting bracket.* A detachable chain-hoist supporting bracket supports one end of each ratchet chain hoist, used to adjust the height of the trestle transom. The bracket is held in place on the column by a pin inserted through one of the holes in the trestle column. A boat snap attached to the end of the pin locks it in place. (See fig. 6.)

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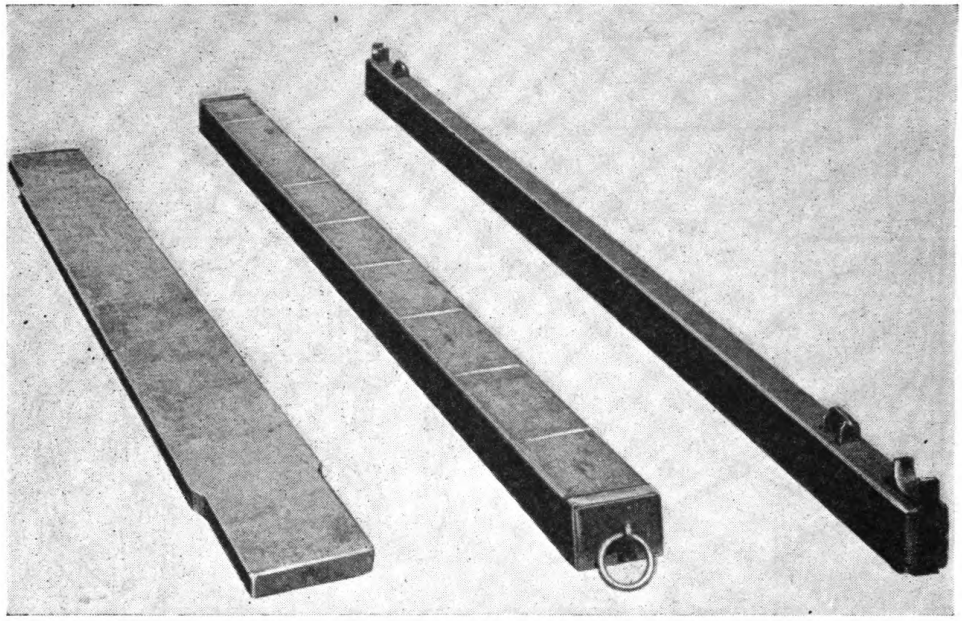

Figure 7. Ten-ton chess, abutment sill, and trestle balk

7. TRESTLE BALK. Ten-ton trestle balk (fig. 7) are used as stringers and siderails in the bridge. A balk, which is made of wood, is 4 by 6 inches by 15 feet 4⅜ inches, and weighs about 100 pounds. Metal fittings at each end fit over the tube on the top of the trestle transom. An eye near each end is used to lash the balk to the transom and provides a handhold for carrying.

8. CHESS. Ten-ton ponton chess (fig. 7) are used to floor the bridge. A chess is made of wood, is 11⅞ by 2⅛ inches by 12 feet, and weighs 75 pounds. It is narrowed at each end to permit insertion of siderail clamps and lashings. Half-chess are provided to fill in small spaces in the decking or for use over transoms.

9. ABUTMENT SILLS. Ten-ton ponton abutment sills (fig. 7) are made of wood, are 5¾ by 7¾ inches by 13 feet, and weigh 135 pounds. They are metal-bound and have rings at their ends. Score marks on each side of the sill indicate the positions of balk. The sill is staked in place by 11 steel pickets.

10. SIDERAILS. Trestle balk are used for siderails. They are placed on top of the chess directly above the outside balk.

11. SIDERAIL CLAMPS. Ten-ton ponton siderail clamps are used to fasten the siderails. They engage under the outside balk and above the siderail, clamping the chess in place between them (fig. 8). A clamp weighs 10 pounds.

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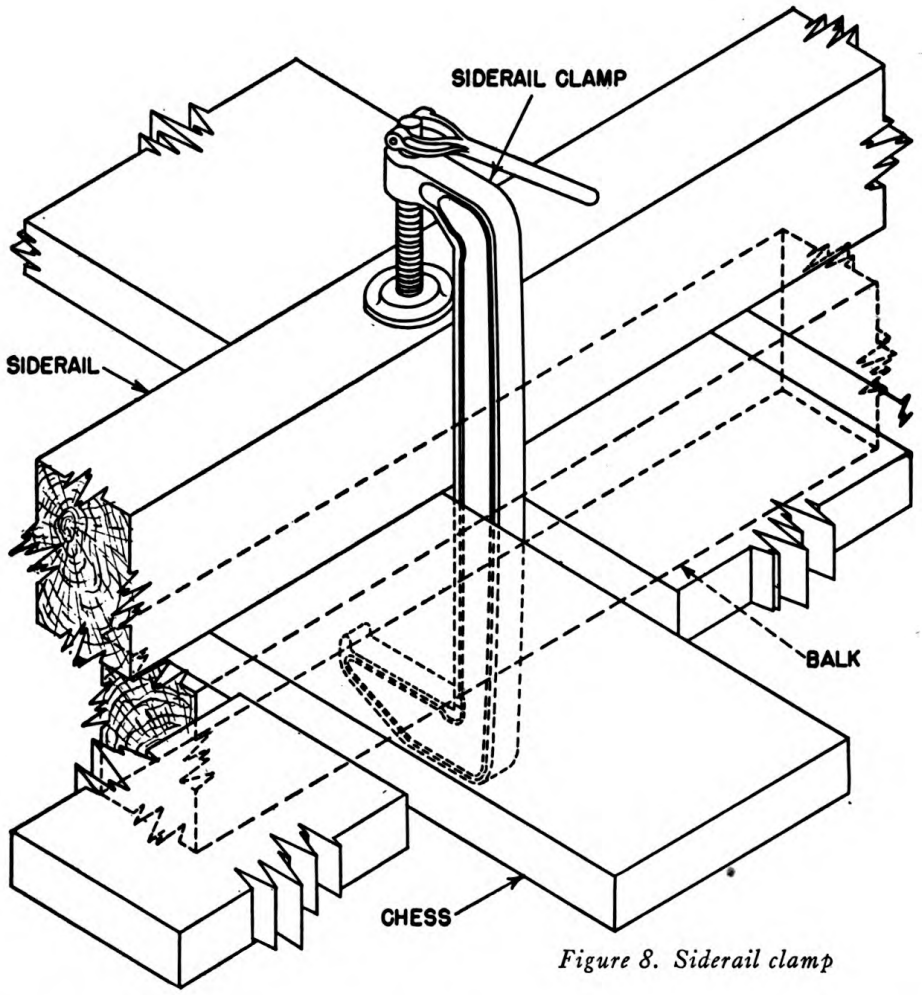

Figure 8. Siderail clamp

12. TRESTLE BRACING. Trestle bracing steadies trestle spans crossed by heavy traffic. Trestle-bracing parts are as follows:

a. Bracing strut. The strut is a 22-foot section of 2½-inch standard pipe with two holes, one 13/16-inch and one 1 5/16-inch, drilled at each end. The smaller hole is for fastening the strut shoe. A picket is inserted through the larger hole to screw the assembled strut and strut shoe into or out of the ground. A bracing strut weighs 125 pounds. (See fig. 9.) The strut should be used only for bracing; other uses or rough handling can easily bend or damage it.

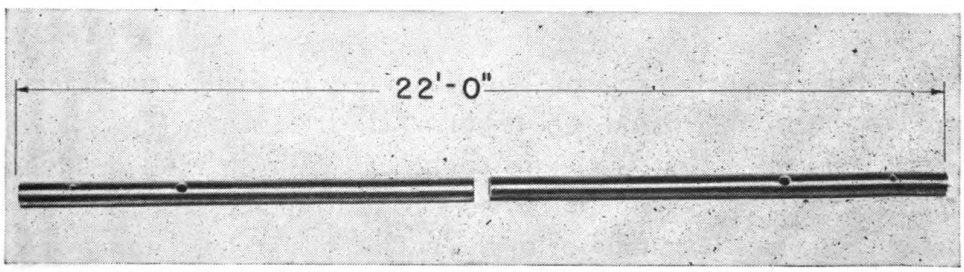

Figure 9. Bracing strut

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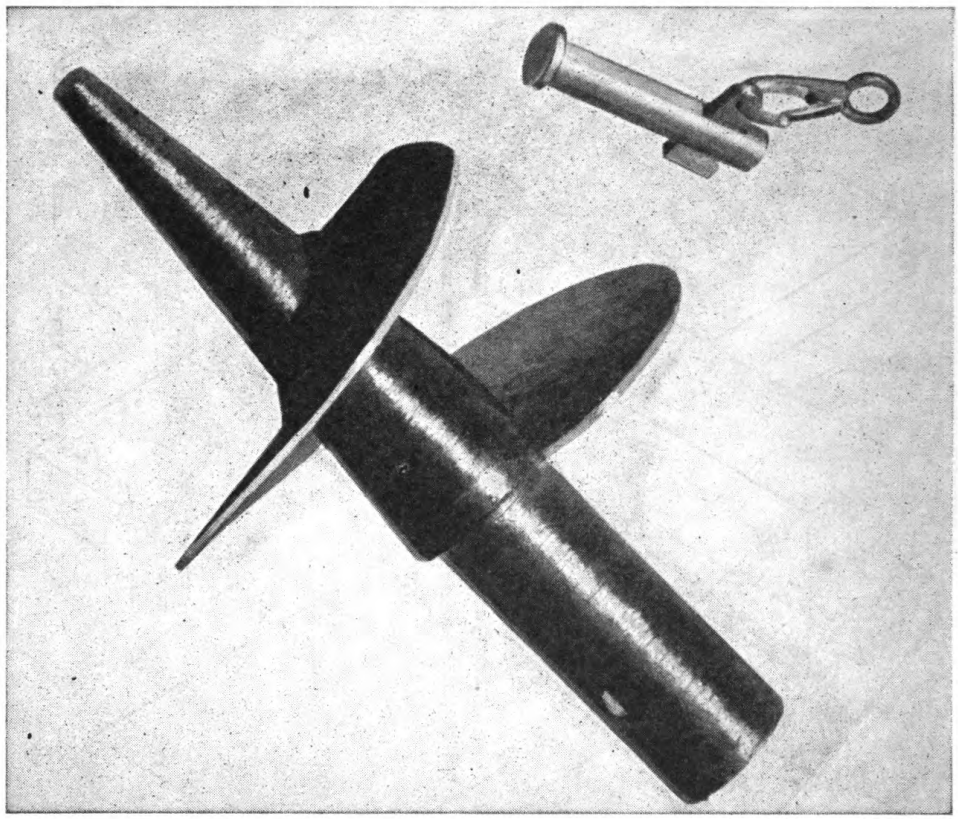

Figure 10. Bracing-strut shoe and strut-shoe pin assembly

b. Bracing-strut shoe. The shoe (fig. 10) is attached to the bracing strut when it is necessary to screw the strut into the ground. The shoe is a steel casting shaped so it may be screwed into soft earth (fig. 34). It weighs 15 pounds.

c. Strut-shoe pin assembly. The strut-shoe pin (fig. 10) fastens the bracing strut to the strut shoe. Through one end of the pin is a latch fitted with a boat snap. To prevent loss of the pin assembly when the strut shoe is removed from the strut, the strut-shoe pin should be replaced in the strut shoe with the latch and boat snap inserted in their proper positions.

d. Column-bracing clamp. This clamp (fig. 11) fastens the bracing strut to the trestle column (fig. 12) or to the anchorpost (fig. 33). It consists of two cast-steel clamps connected by a swivel joint. The smaller of the two clamps is fastened to the bracing strut, and the larger to the trestle column or to the anchor post. The clamp weighs 18 pounds.

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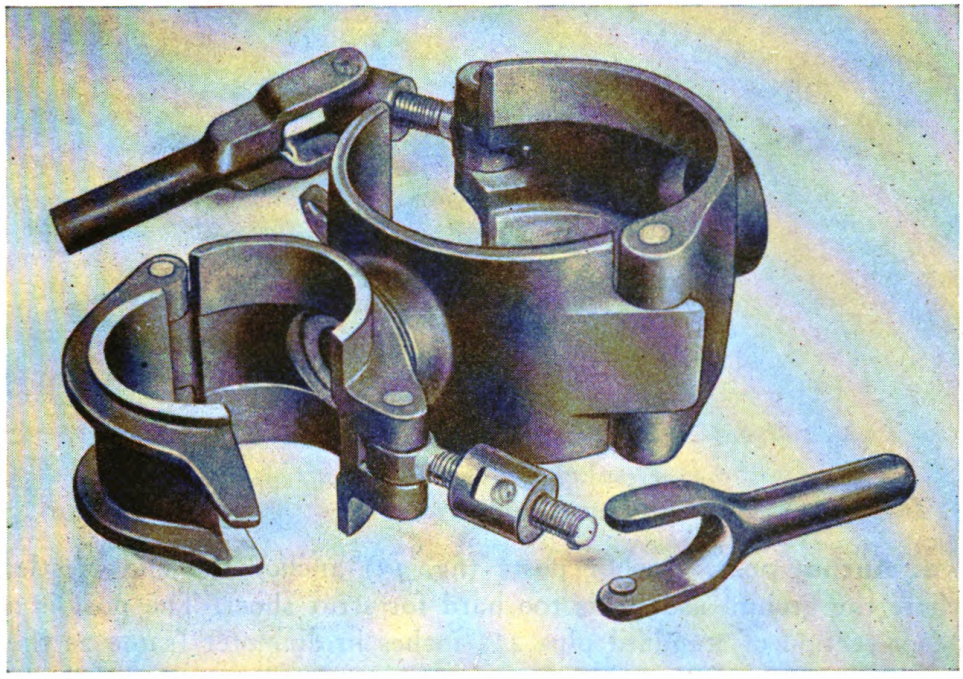

Figure 11. Column-bracing clamp

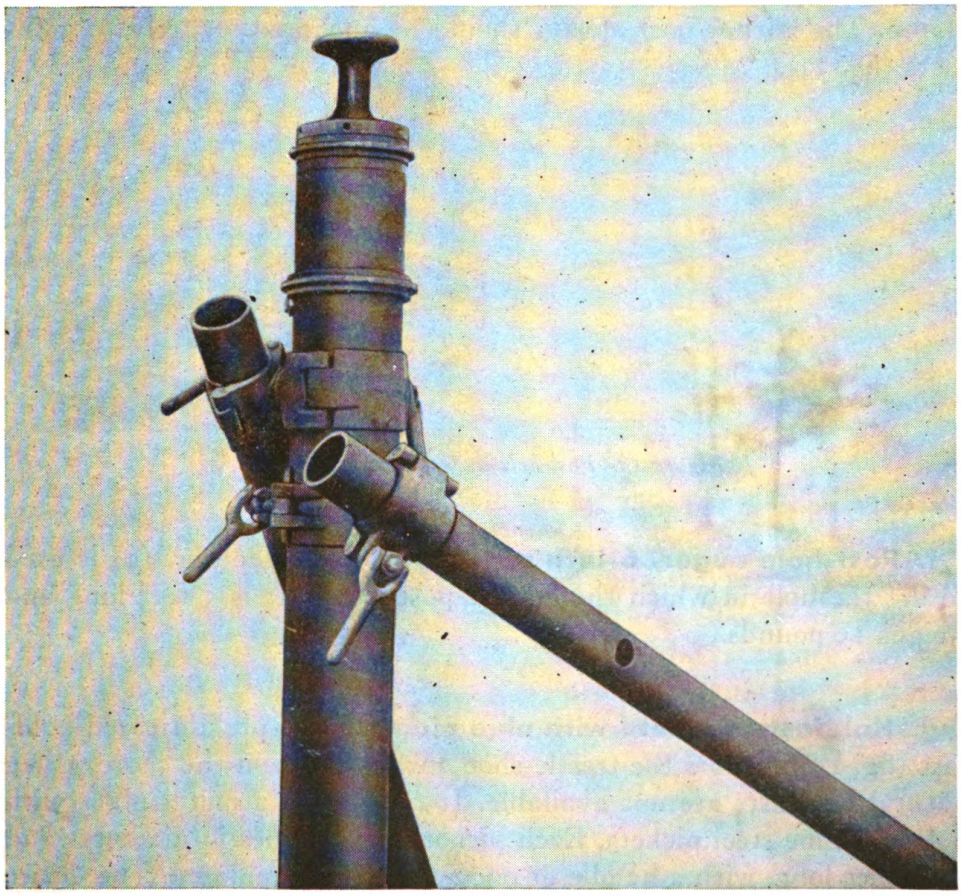

Figure 12. Column-bracing clamp used to fasten bracing strut to trestle column

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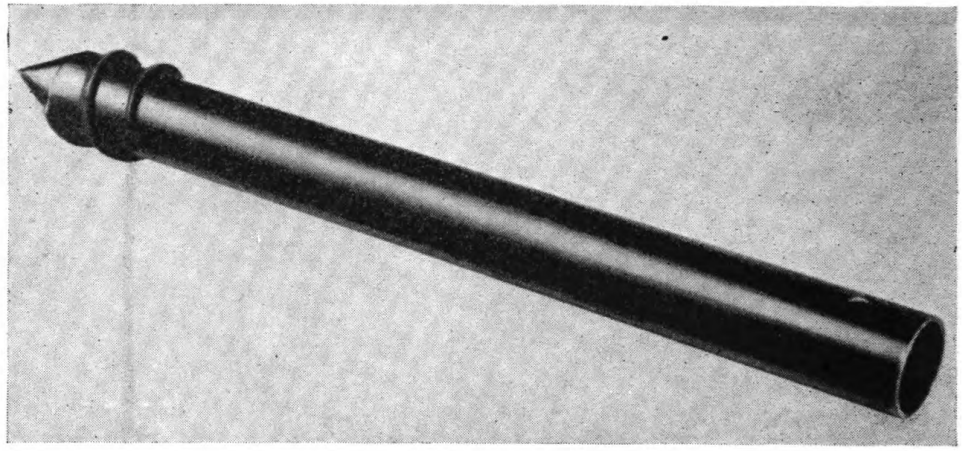

Figure 13. Ten-ton anchor post

e. Anchor post. Anchor posts (fig. 13) anchor the end trestle, where the ground usually is too hard for strut shoes. The post is a 5-foot section of standard pipe 4½ inches in diameter (same as the trestle column) with a spiral flange at one end. The other end has a 1 5/16-inch hole for inserting a picket used to screw the post into a hole. A bracing strut is attached to the anchor post with a column-bracing clamp. The anchor post always should be anchored securely to holdfasts (fig. 33).

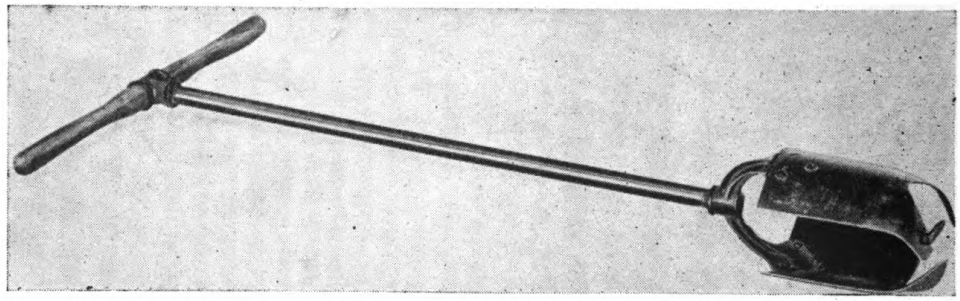

Figure 14. Post-hole auger, 6-inch capacity

f. Post-hole auger, 6-inch capacity. This auger (fig. 14) is used to dig the hole in which the anchor post is set. It is 5 feet long and weighs 15 pounds.

g. Holdfast, complete with nine pickets. This prefabricated holdfast (fig. 15) anchors the trestle-shoe anchor cable on the shore, when natural holdfasts are not available. It consists of a metal plate with holes for nine steel pickets. Each picket is 1¼ inches in diameter and 42 inches long, with a handle at one end for easy removal. The entire holdfast weighs 25 pounds, and each picket weighs 15 pounds.

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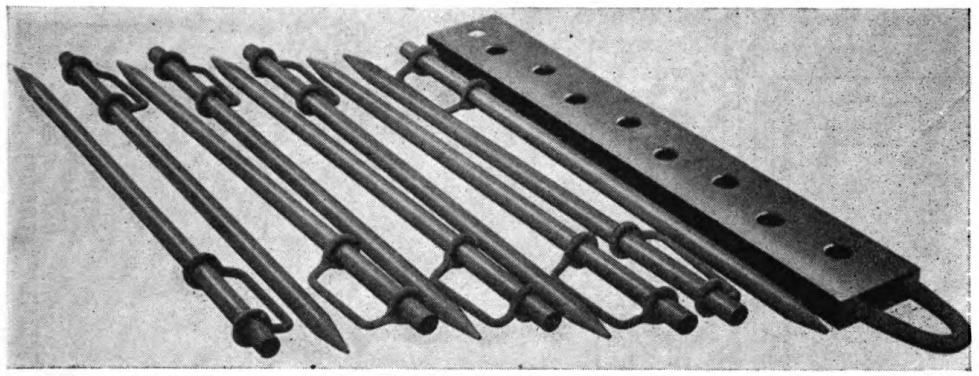


Figure 15. Holdfast with 9 pickets

h. Grip for ½-inch wire rope. This grip, (or come-along) (fig. 16) is used to attach the ratchet chain hoist to the trestle-shoe anchor cable to tighten the cable. Two grips usually are required for this; one is sufficient, however, if the free end of the cable ends in an eye. (See par. 22*d*.)

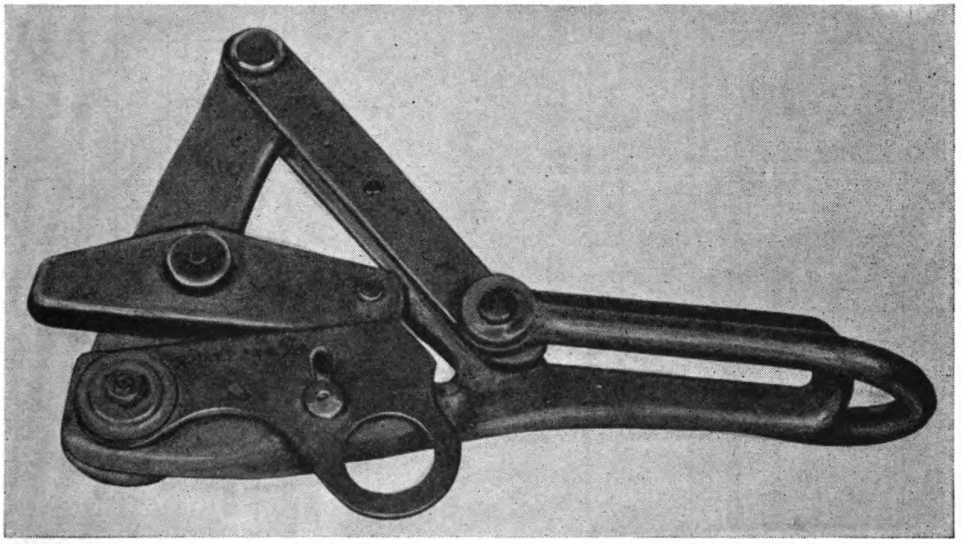
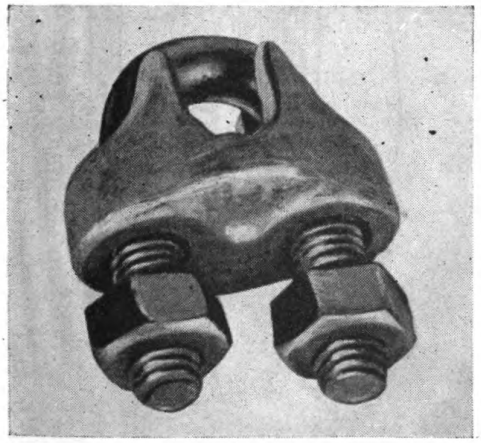


Figure 16. Grip for ½-inch wire rope



i. Clip for ½-inch wire rope. Wire-rope clips (fig. 17) are used to bind two sections of wire rope together. Three or four clips should be attached at 3-inch intervals. The grip of the clip should bear against the standing part of the rope.

Figure 17. Clip for ½-inch wire rope

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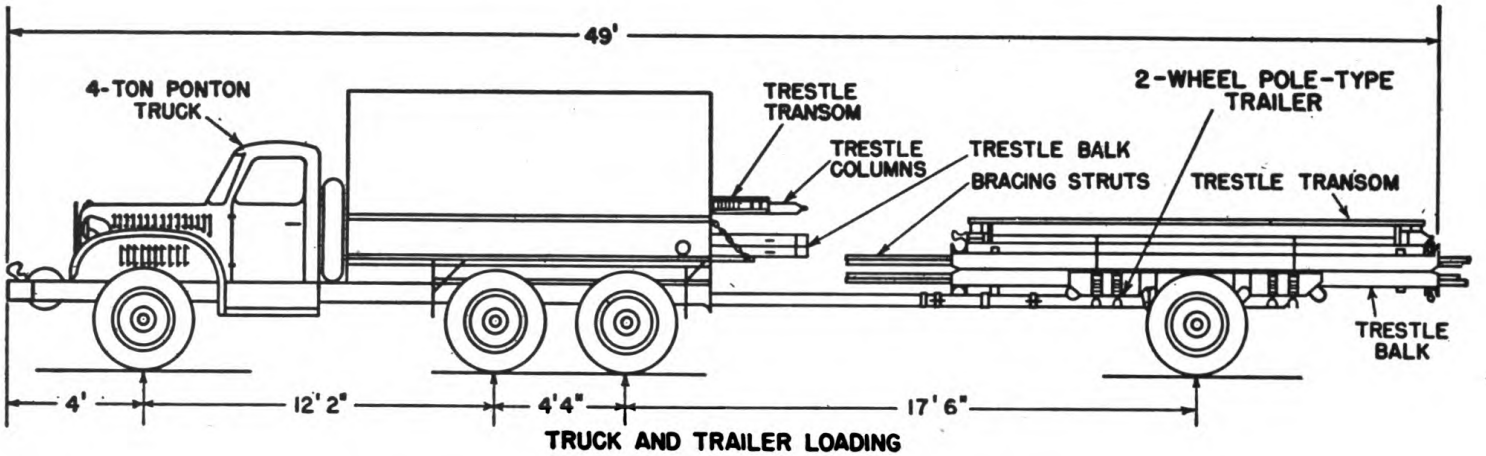

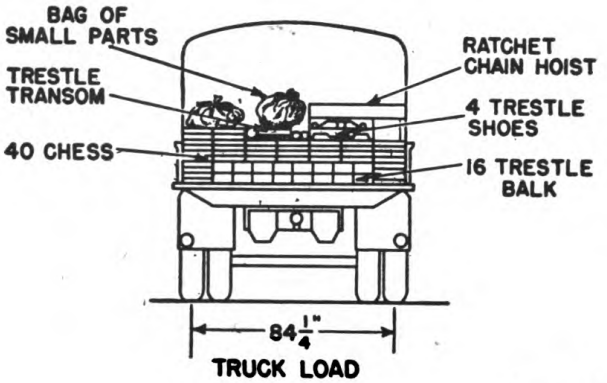

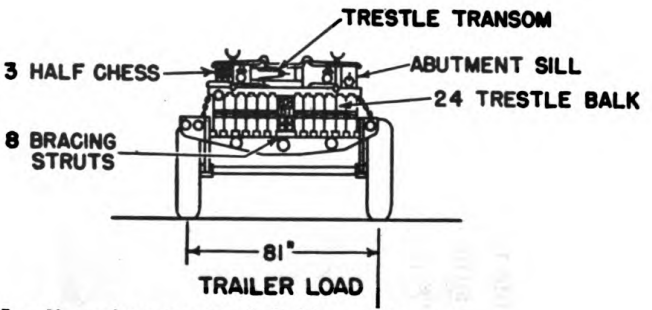

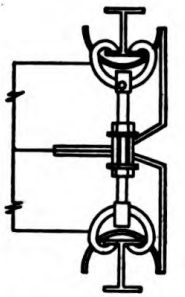

Figure 18. Loading of 10-ton trestle-bridge equipment

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SECTION III

TRANSPORTATION AND LOADINGS

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13. TRANSPORTATION a. General. One unit of a 10-ton trestle bridge normally is transported on two two-wheel, pole-type trailers drawn by two 4-ton ponton trucks. (See fig. 18.)

b. Two-wheel trailer. (1) The two-wheel pole-type trailer with pneumatic tires has a rectangular frame with a drawbar of adjustable length. The drawbar is telescopic, permitting three adjustments in length. A rest supports it horizontally when the trailer is unhooked from the prime mover.

(2) A load is made fast to the trailer by clamping beams held in position with hand-operated screws and chain links. When the trailer is not loaded, the clamping beams are held in brackets especially provided for that purpose.

(3) The empty trailer, with a spare tire, weighs about 2,300 pounds.

c. Prime mover for two-wheel trailer. This is a 4-ton ponton truck with a 12-foot 3-inch loading bed, which will accommodate standard chess.

d. Loaded weights. The weight of properly loaded vehicles is as follows:

	Pay load	Gross weight
Truck	7,000	25,800 pounds
Trailer	4,500	6,800 pounds

14. LOADINGS a. General. The two truck and trailer loads are practically identical. One truck and trailer load provides equipment for one abutment span and one and one-half trestle spans. The combined loads provide equipment for a complete bridge 75 feet long (five spans).

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b. Detailed loading of two-wheel trailer (see fig. 18).

CONTENTS OF TWO-WHEEL TRAILER LOAD

Item	Total	Trailer	
		1	2
Balk, trestle, 10-ton	48	24	24
Chess, half, ponton, 10-ton	6	3	3
Sill, abutment, 10-ton	2	1	1
Strut, bracing	16	8	8
Trestle, without hoists and shoes	2	1	1

c. Detailed loading of 4-ton ponton truck (see fig. 18).

CONTENTS OF 4-TON PONTON TRUCK LOAD

Item	Total	Truck	
		1	2
Auger, post-hole, 6-inch capacity	1	1	0
Balk, trestle, 10-ton	32	16	16
Bolt, clamp, column	6	3	3
Chess, ponton, 10-ton	80	40	40
Chest, ratchet chain-hoist, 1½- to 3-ton	2	1	1
Clamp, column-bracing, 10-ton	32	16	16
Clamp, siderail, ponton, 10-ton	36	18	18
Clip, wire-rope, ½-inch	40	20	20
Grip, wire-rope, ½-inch	2	1	1
Hoist, chain, ratchet, 1½- to 3-ton	4	2	2
Holdfast, complete with nine pickets	2	1	1
Nut and handle, assembly, clamp	6	3	3
Picket, steel, 36-inch	32	16	16
Pin assembly, strut-shoe	19	10	9
Post, anchor, 10-ton	4	2	2
Shoe, bracing-strut	16	8	8
Shoe, trestle, 10-ton	8	4	4
Trestle, 10-ton, without hoists and shoes	2	1	1

d. Loading equipage. All the equipage of the 10-ton trestle bridge can be loaded on the trucks and trailers by hand.

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SECTION IV

SELECTION AND PREPARATION OF SITE

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15. GENERAL. A bridge site is selected to meet both technical and tactical requirements. For tactical requirements see FM 5–6.

16. TECHNICAL REQUIREMENTS. The following technical characteristics are desirable:

a. Approaches. Approaches should permit quick construction of approach-road connections on both sides of the gap.

b. Banks. Banks should be firm, to support the abutment sill and to hold deadmen or holdfasts. They should not be so high or steep as to require excessive grading for the approach, nor so low that normal rises in water level will overflow the site or unnecessarily increase the length of the bridge.

c. Bed. Bed should be firm to support trestles. If the gap is water-filled, a careful underwater examination of the area to be occupied by trestles should be made, so that obstructions such as stumps and snags may be removed.

d. Holdfasts. Trees or other natural holdfasts should be present near the bank for fastening trestle-shoe anchor cables.

17. PREPARATION OF SITE a. The approach road should be constructed and the bridge site prepared and cleared prior to arrival of bridge equipage.

b. The site lay-out must be adjusted to fit the terrain. The abutment site requires space for the abutment, for unloading trucks and trailers, and for stacking equipment. Where stacking space is not available at the site, the bridge may be built directly from the trucks and trailers.

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SECTION V

CONSTRUCTION OF BRIDGE

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18. GENERAL. In this section bridge construction is described without reference to organization of personnel. A suggested organization of personnel, with detailed duties of each working section, is given in section VI. Normally, the bridge is constructed from the near bank by successive trestles.

19. ABUTMENTS a. Near-bank abutments. (1) *Centering and squaring sill.* Two stakes are driven on the center line of the bridge, one at the location of the sill and the other about 20 feet farther from the gap. The middle of the far-bank side of the sill is laid against the stake. Distances from the second stake to the ends of the sill are measured with a tape or lashing. The sill is squared when its middle is on the center line of the bridge and these two distances are equal. (See fig. 19.) After centering and squaring, the outline of the sill is marked on the ground as a guide in excavation.

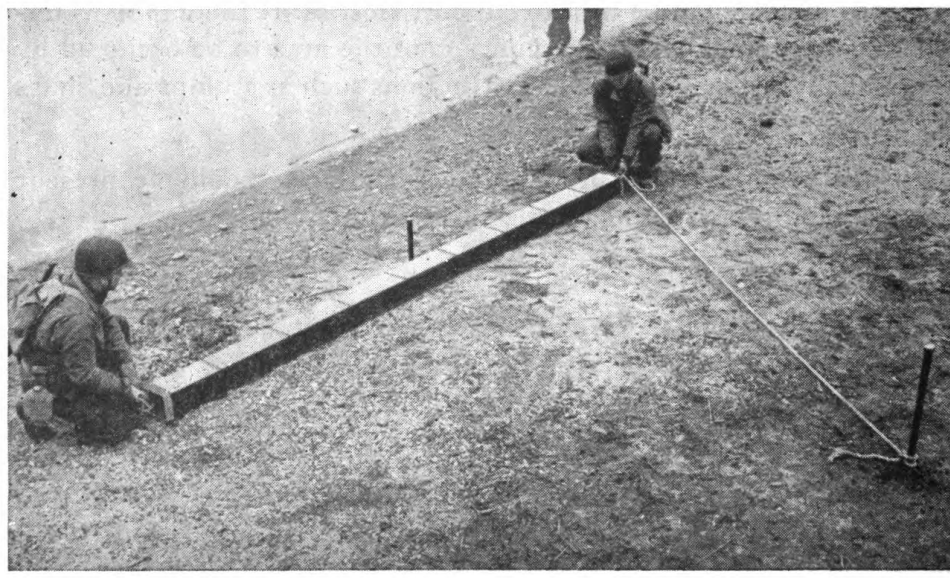

Figure 19. Squaring abutment sill

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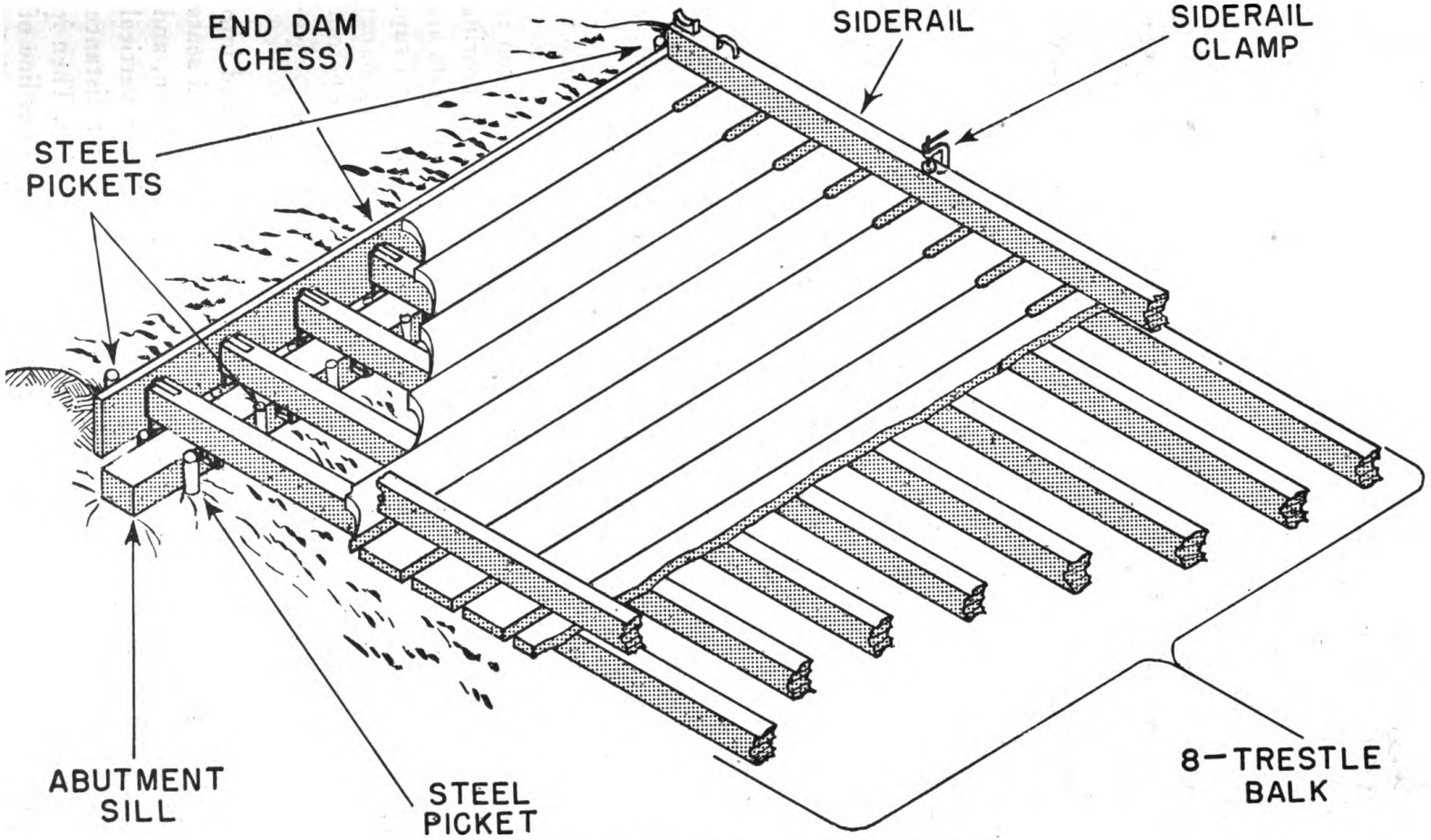

Figure 20. Abutment with balk and end dam in position

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(2) *Placing sill.* The ground is leveled for the sill, allowing space for the end dam and projection of abutment-span balk on the near-bank side of the sill. The sill is fixed in place by 11 pickets, 9 on the side of the sill toward the bridge between score marks, and 2 on the side away from the bridge near the ends of the sill.

(3) *Placing end dam.* After abutment-span balk are in position on top of the sill, a chess is placed on edge against the ends of the balk, its upper edge level with the flooring. This chess is the end dam. It is held against the balk by two pickets near each end. Road metal is filled and tamped against the end dam to 1 inch above the flooring. (See fig. 20.)

b. Far-bank abutment. The far-bank abutment is constructed as soon as its position can be determined after erection of the far-bank trestles. When the bridge crosses water, materials for the far abutments are moved to the far bank on the raft used to erect deep-water trestles.

20. TRESTLES a. Shallow-water trestles. There are two methods of erecting a shallow-water trestle:

(1) *Erection with bracing struts.* (*a*) *Assembly:* The trestle is assembled on its side, as near to its final position as possible without interfering with installation of the abutment sill. The transom is placed on its side on top of two trestle balk, lying one on top of the other in the shallow water. Trestle columns are inserted in the transom and held with trestle pins, using the lowest set of holes in the column that the difference in elevation of footings allows. Trestle shoes are attached to the foot of the columns and fastened by hooks chained to the shoes. Wire ropes are attached to the shoes so that they can be anchored to holdfasts. If necessary, expedient footings for increasing the bearing area of the shoes are prepared. (See par. 21.) Ratchet chain hoists are hooked in place, with the hoist end hooked to the transom stirrup. A bracing strut is attached to the top of each column by a column clamp, which is tightened snugly but left just free enough to permit it to turn about the column, in order to prevent shearing the connection bolt when the trestle is erected. (See fig. 21①.)

(*b*) *Erection.* The assembled trestle is raised and manhandled into position as soon as the abutment sill is properly embedded and seats for the trestle shoes are prepared. Three men raise each column, and two men hold each bracing strut to guide the trestle into a vertical position. (See fig. 21②.) The trestle is spaced at the proper distance from the abutment sill by placing the outer balk in position. Then it is moved by hand until it is plumb and centered on the center line of the bridge. The other six balk then are delivered and placed, and the trestle bracing is completed.

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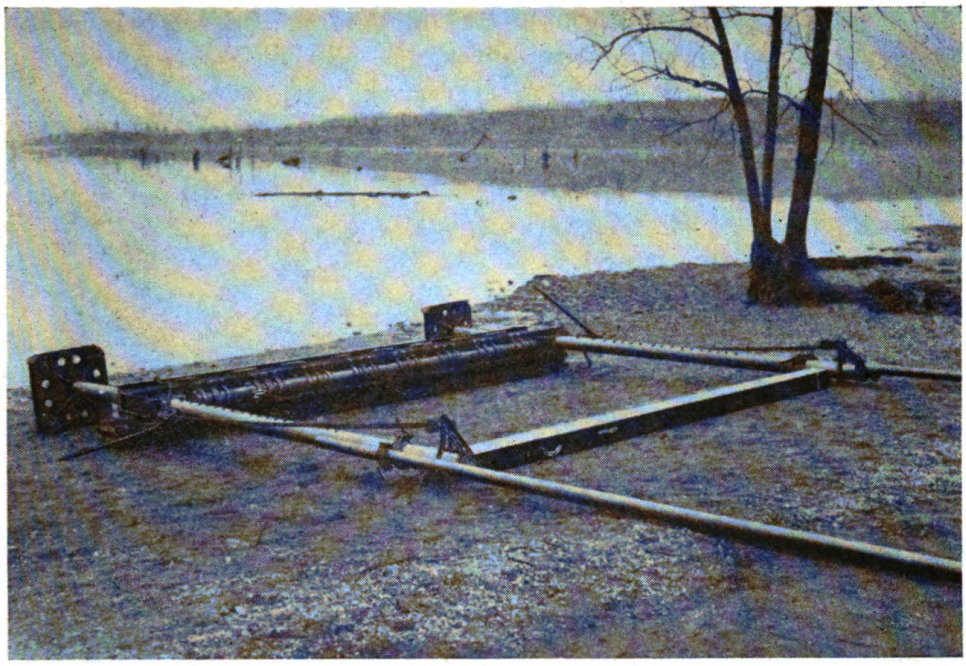

① *Assembly*

② *Erection*

Figure 21. Trestle with bracing struts

(2) *Erection with guy lines.* (*a*) *Assembly.* The trestle is assembled on its side without bracing struts. Two ½-inch rope guy lines, about 60 feet long, are made fast by clove hitches at their middle points to the spools at the tops of the trestle columns. (See fig. 22①.)

(*b*) *Erection.* To erect the trestle, three men raise each column and two men handle each end of the guy lines, which steadies and plumbs

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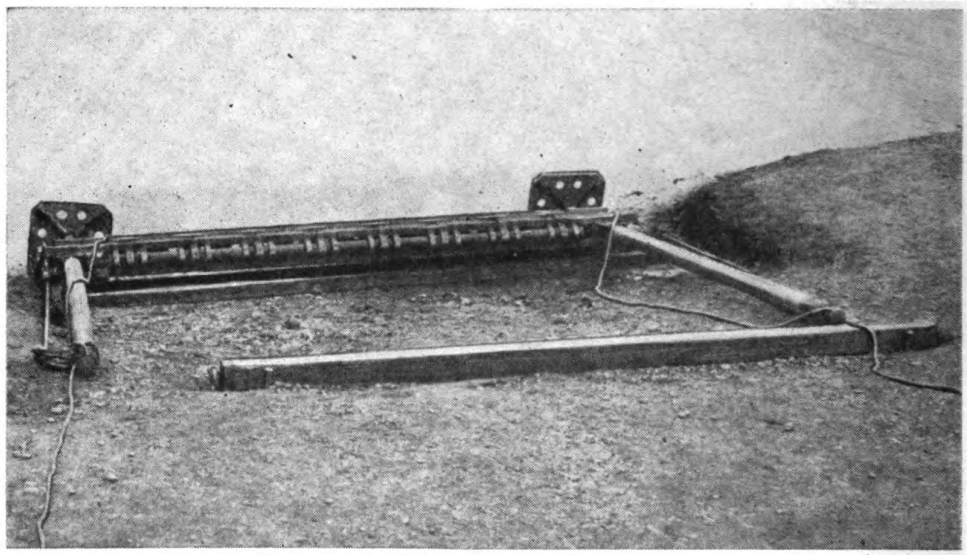
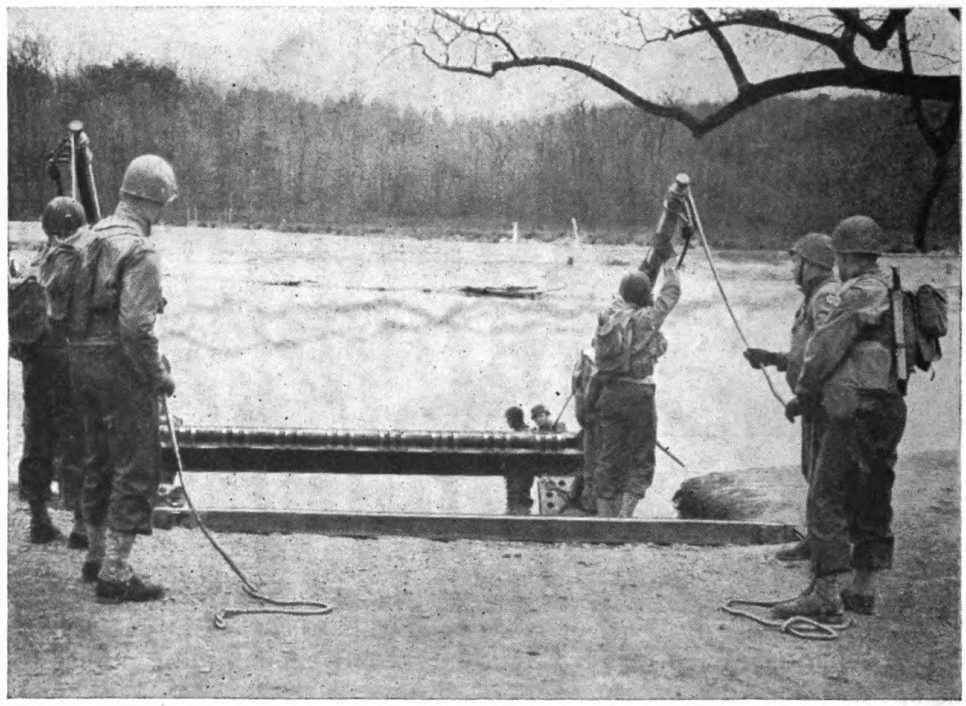
the trestle while it is being raised and manhandled into final position. The lines are not required after the trestle balk have been placed in position. (See fig. 22.) Trestle-bracing struts are fastened to the top of the columns after the trestle is erected, pickets being placed through holes in the trestle columns to form ladder rungs for climbing. (See fig. 23.)



① *Assembly*



② *Erection*

Figure 22. Trestle with guy lines

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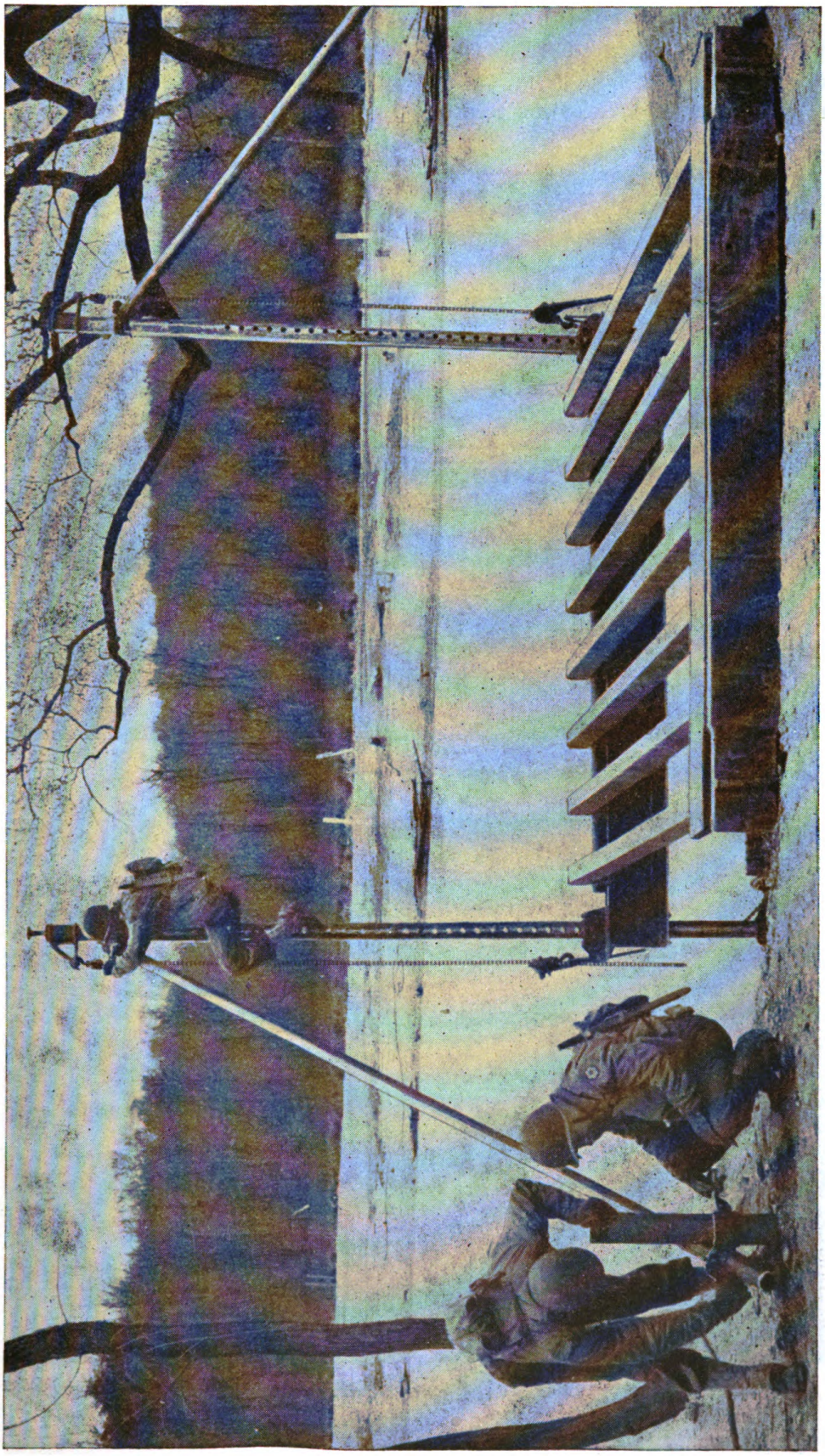

Figure 23. Installing trestle-bracing strut after erection of trestle

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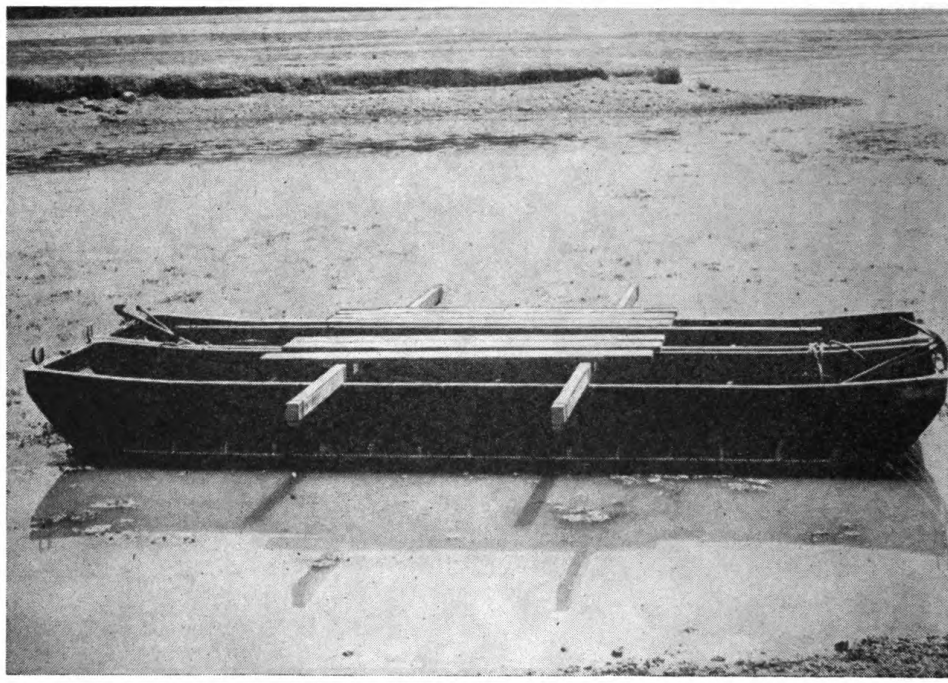
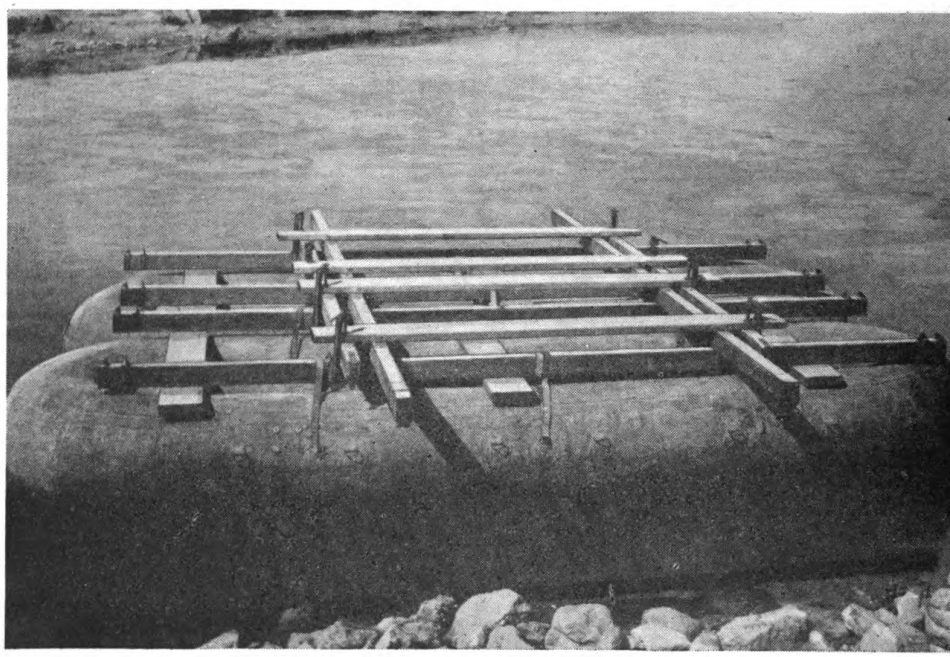
b. Deep-water trestles. Deep-water trestles are assembled and floated into position on a raft constructed of 10-ton pontons (fig. 24①) or of pneumatic floats (fig. 24②). Either bracing struts or guy lines may be used to steady the trestle as it is raised to position.



① *Ten-ton ponton raft*



② *Pneumatic raft*

Figure 24. Raft used to erect deep-water trestles

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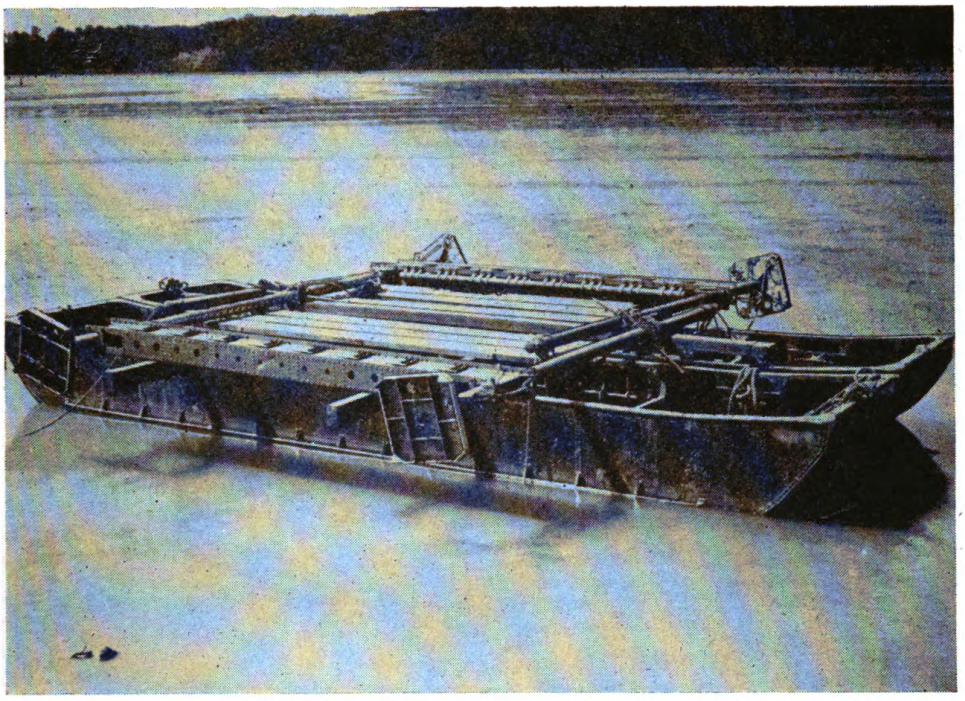
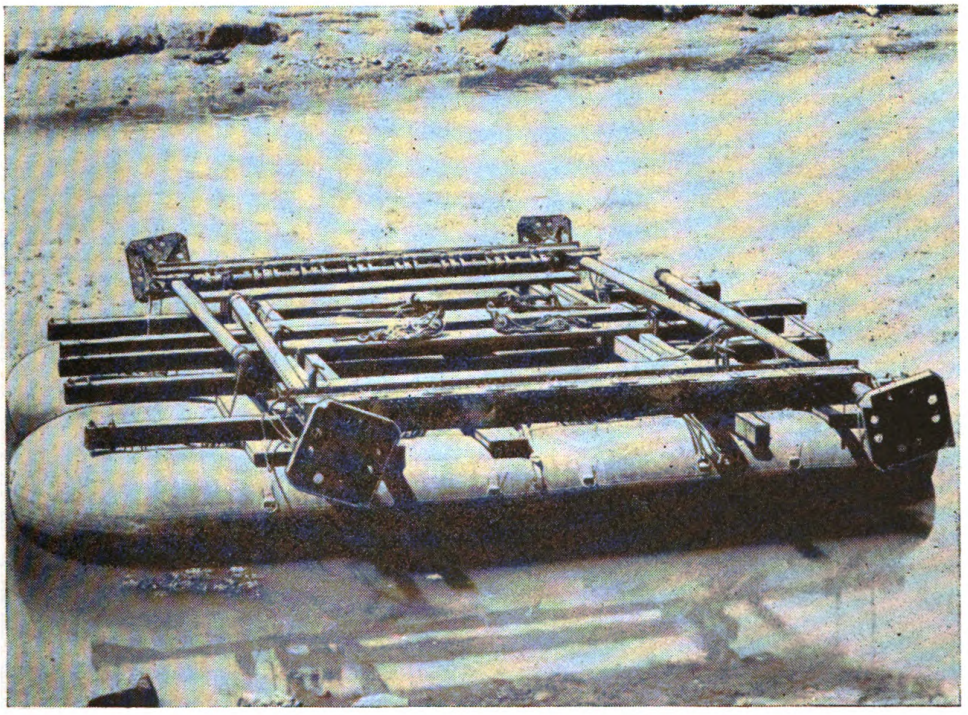


① *Ten-ton ponton raft*



② *Pneumatic raft*

Figure 25. Deep-water trestles assembled on raft

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Figure 26. Attaching lashing to trestle shoe of deep-water trestle

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(1) *Assembly of trestle.* The trestle transom is placed on its side on two balk projecting shoreward from the raft. Trestle columns are inserted in the transom with their upper ends riverward and with about 2 feet of the columns projecting shoreward beyond the bottom of the transom. The upper portions of the columns rest across a balk laid lengthwise on the raft. Trestle shoes are attached to the columns. Transom pins are not inserted, but the columns are fastened to the transom by ½-inch lashings tied to the shoes and transom stirrups as shown in figure 26. Releasing the lashing at the stirrup after the trestle is floated into position causes the columns to slide through the transom and the trestle shoes to drop into their seatings. Anchor cables of ½-inch wire rope also should be attached to the shoes so that they can be anchored to holdfasts.

① *Ten-ton ponton raft*

Figure 27. Alining deep-water trestle

(2) *Erection of trestle.* When the raft with trestle assembly reaches the center line of the bridge the trestle is raised, guy lines or bracing struts being used to steady and plumb the trestle. Outside trestle balk are laid to space the trestle. The raft is manouvered until the center of the transom is on the center line of the bridge. Then the officer in charge orders the trestle columns dropped (fig. 27). Chain hoists are attached, the trestle transom is raised clear of the raft, and transom pins are inserted. Trestle bracing is installed and decking laid. The raft returns to its site to pick up another trestle.

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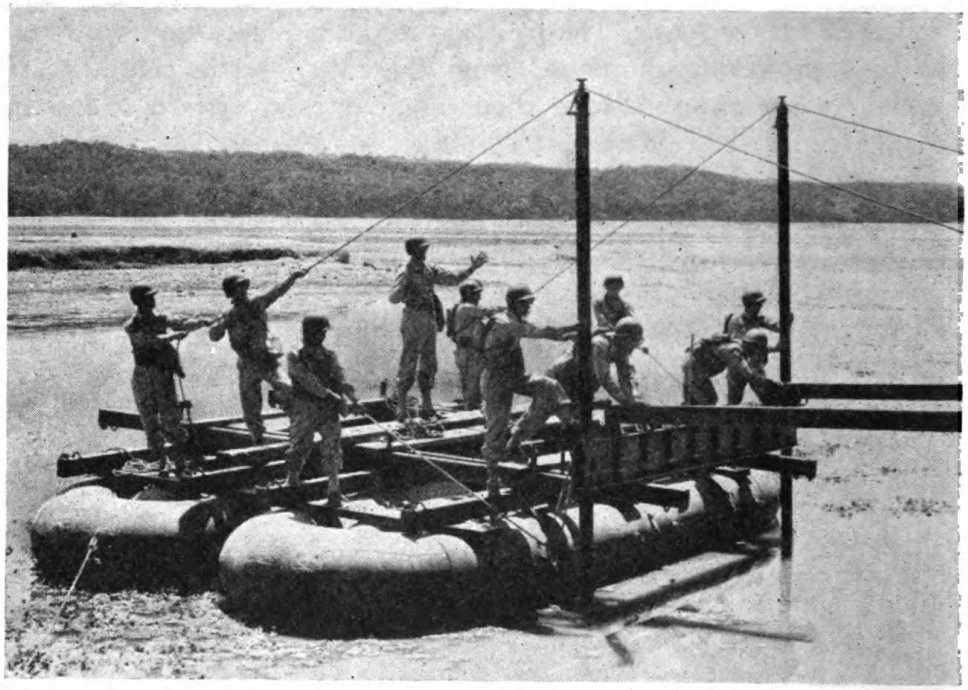

② *Pneumatic raft*

Figure 27. Alining deep-water trestle—Continued

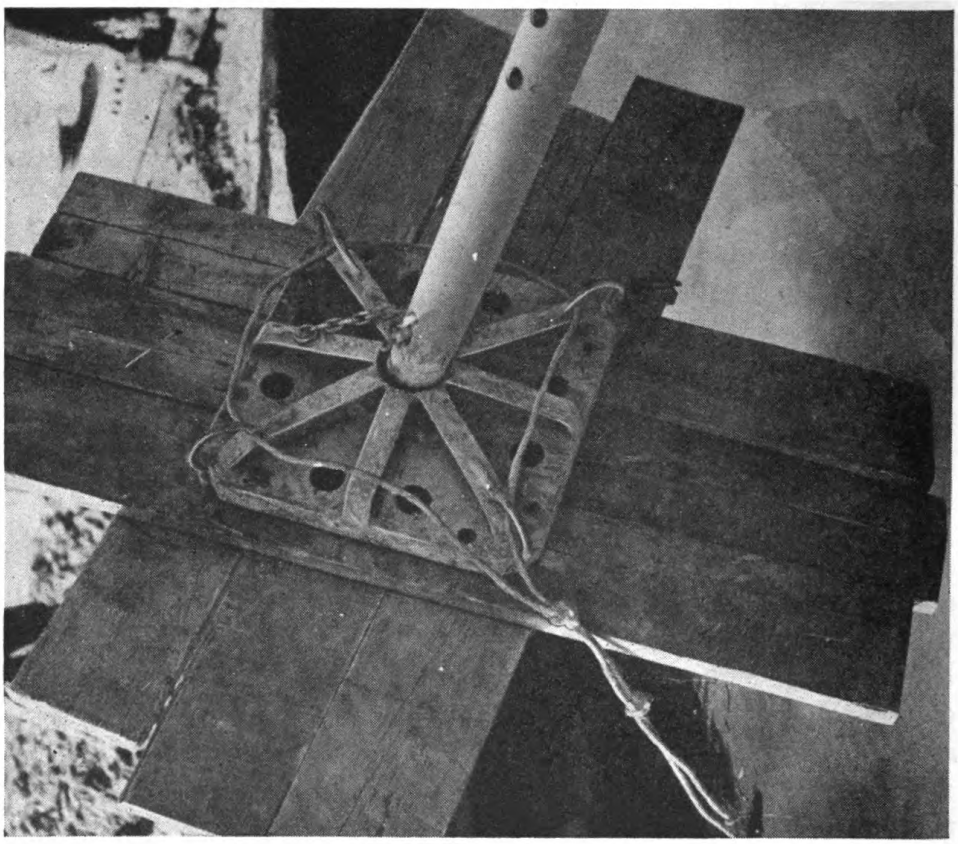

Figure 28. Expedient method of increasing bearing area of trestle shoes

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21. TRESTLE FOOTINGS. Under repeated crossings of heavy loads, trestles on sandy or muddy river beds settle excessively. Trestle columns bend if one shoe settles appreciably more than the other. Figures 28 and 29 illustrate types of expedient footings used to increase bearing area under trestle shoes. These spread footings are lashed to the trestle shoes prior to setting the trestle. Panels of steel grating or airplane landing mat, lashed under the footings, help prevent them from slipping riverward. An extra transom set vertically, with pins in the lowest holes on the column and logs or planks under the transom, like mud sills, also will lessen slipping and will add rigidity to the columns. Such an expedient is difficult to move, however. Even with the aid of these expedients, trestles will need continuous maintenance. (See sec. VIII.) Careful selection of the bridge site, and proper preparation and leveling of foundations for footings, will reduce maintenance.

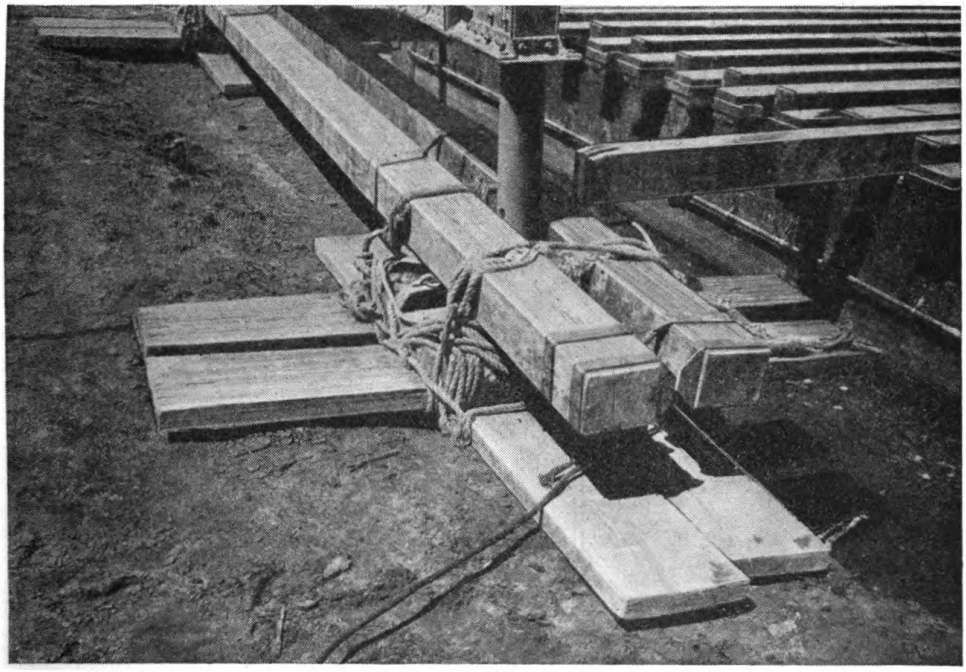

Figure 29. Another expedient method of increasing bearing area of trestle shoes

22. TRESTLE BRACING a. Conditions influencing type of installation. The type of trestle bracing used depends mainly upon stability of the soil at the site.

(1) On *unstable foundations*, where settlement of individual trestles is probable, it is desirable to make an integral unit of each trestle and its bracing, normally using two bracing struts from the top of each trestle column to the ground at the sides. This is called *tripod bracing*. (See fig. 30.)

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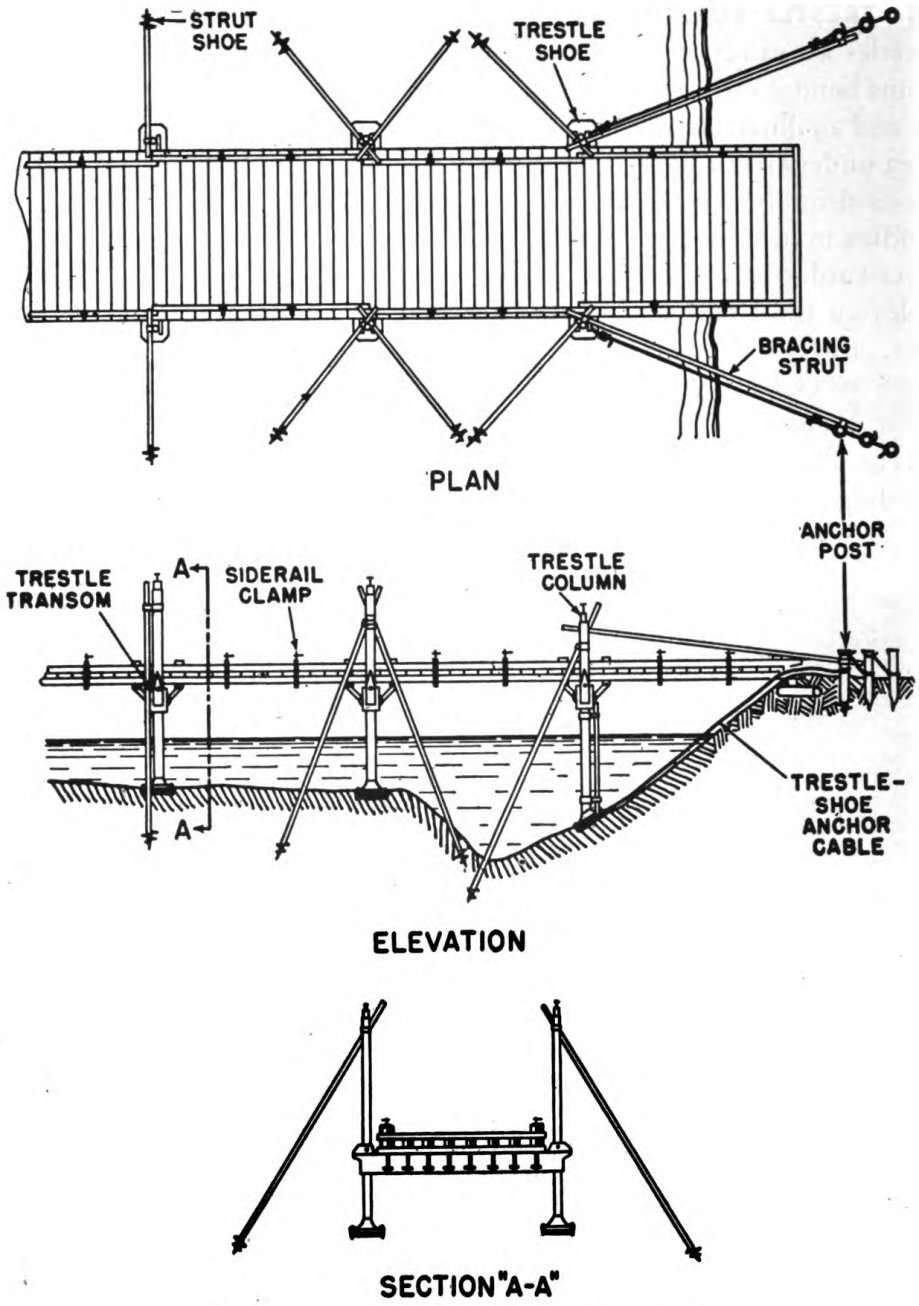

Figure 30. Trestle bracing, unstable foundations

(2) On *semistable foundations*, where little settlement is probable, adjacent trestles are connected with *single diagonal bracing*. (See fig. 31.)

(3) On *stable foundations* adjacent trestles are connected with *double diagonal bracing*. (See fig. 32.) Where four or more trestles are used, only alternate spans are braced, each pair of trestles thus forming a pier.

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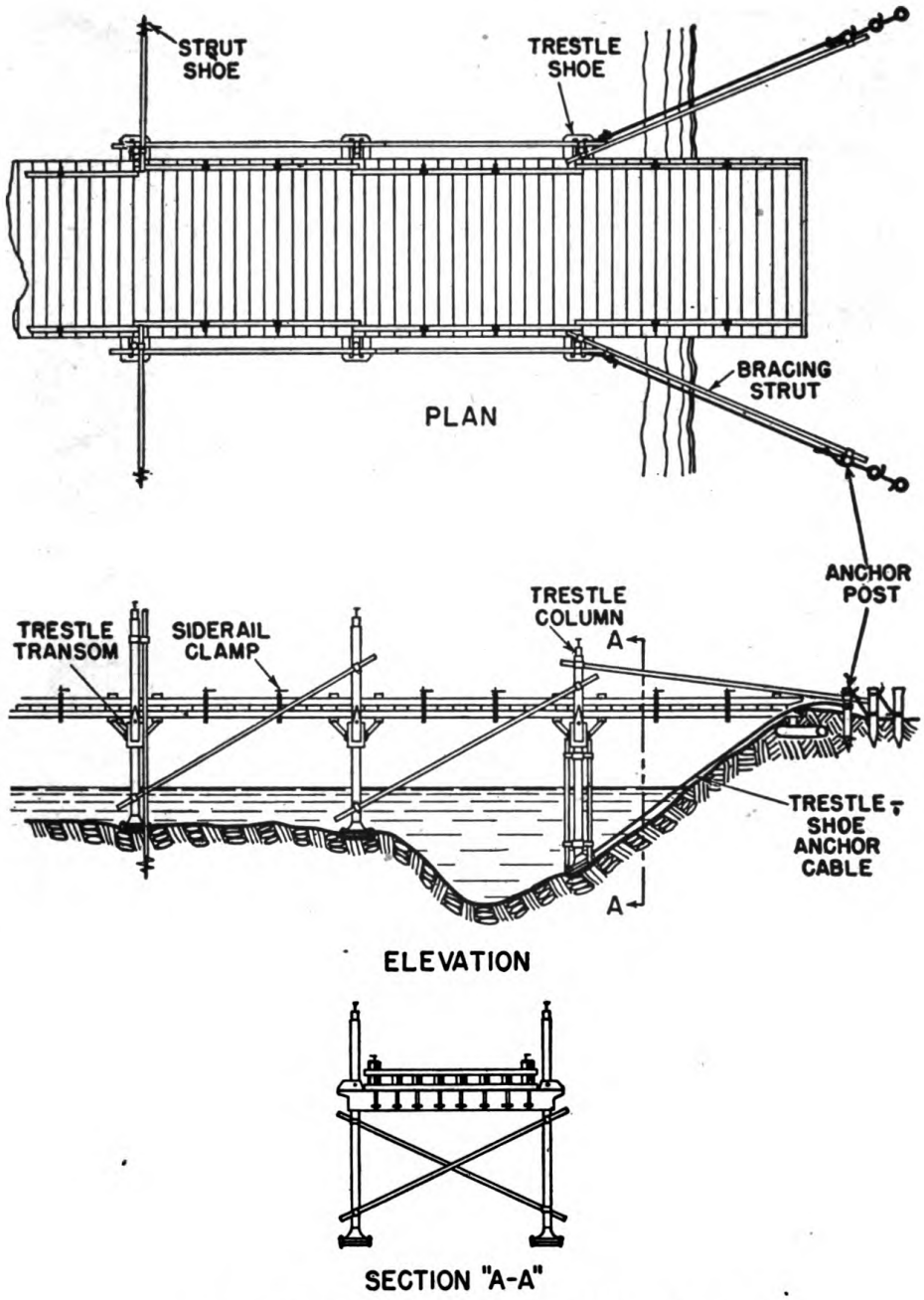

Figure 31. Trestle bracing, semistable foundation

(4) When the trestle transom is near the top of the trestle columns, *transverse bracing* is necessary to provide lateral stability. On an *unstable foundation*, this is a single diagonal strut between columns under the trestle; on *stable* or *semistable* foundations, it consists of two transverse diagonal struts (X-bracing) (fig. 31).

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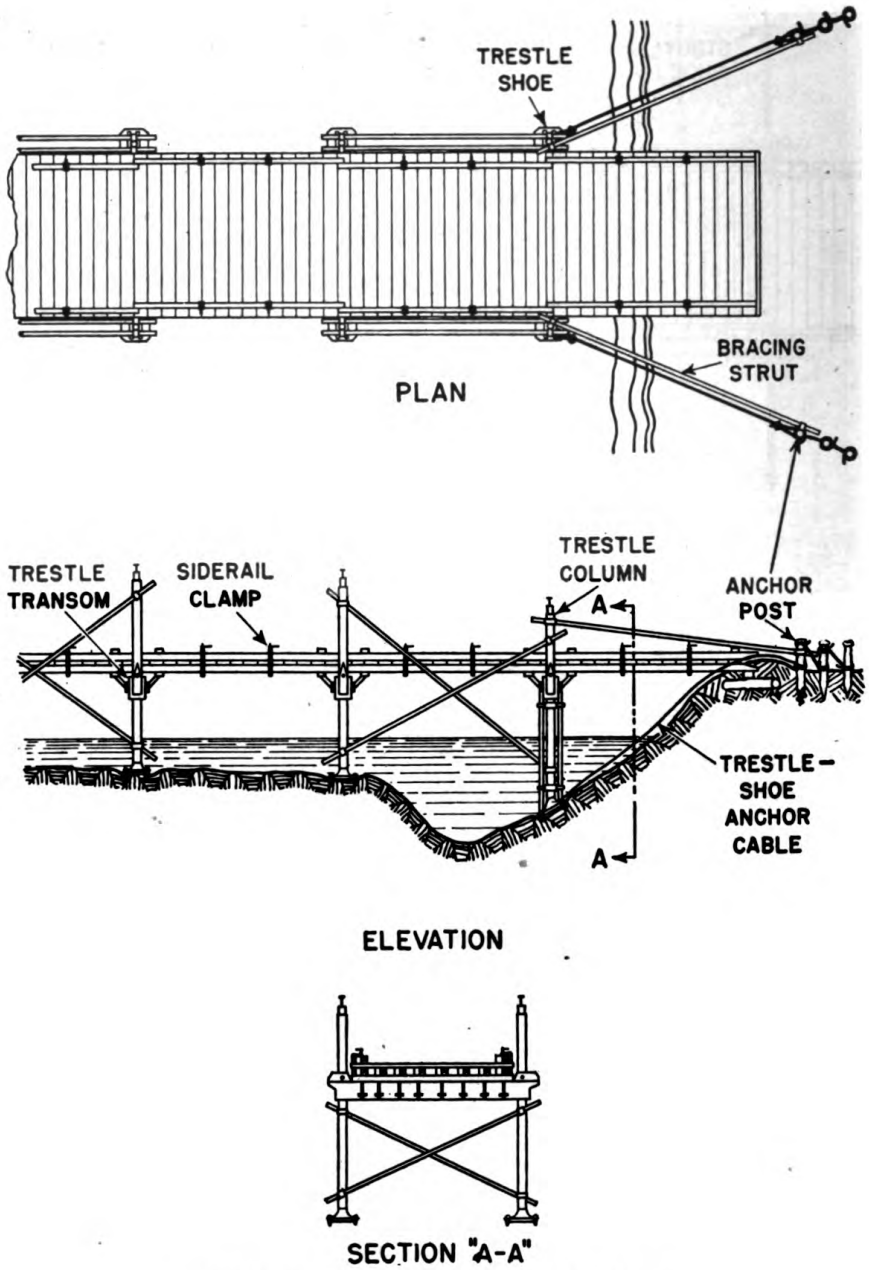

Figure 32. Trestle bracing, stable foundation

b. Bracing end trestle. (1) The end trestle on *any type of foundation* is braced from the shore by bracing struts from the top of the end trestle columns to anchor posts in holes, dug with the post-hole auger, on each side of the approach. Each bracing strut is fastened to the anchor post near the ground by a column-bracing clamp. The anchor post should be anchored securely to holdfasts (fig. 33).

(2) On *unstable foundations* the end trestle is further braced in a tripod manner by running a second bracing strut from the top of each column to the ground alongside the bridge. (See fig. 30.)

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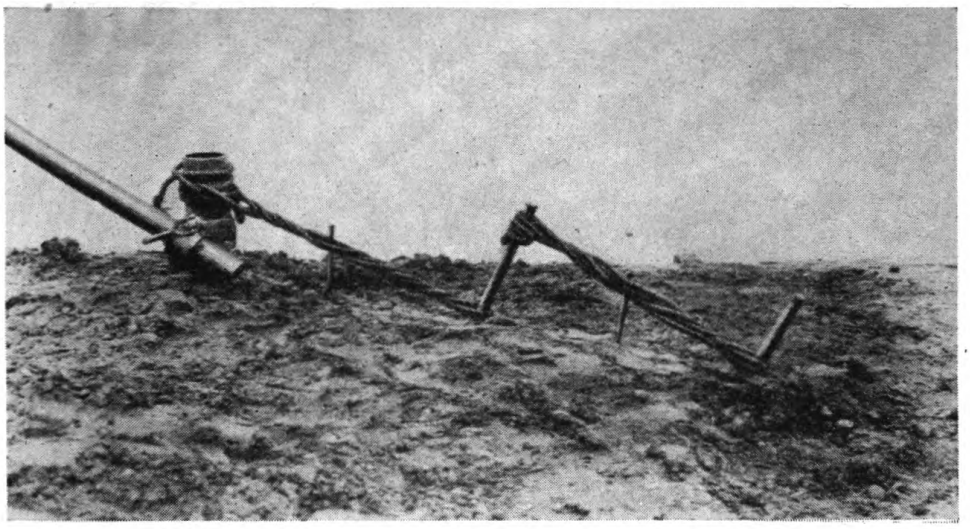

Figure 33. Anchor post in use

c. Bracing intermediate trestles. (1) *Unstable foundation.* Normally, use tripod bracing to make the trestle and its bracing act as a unit. A single strut from the top of each column may be used on interior trestles. (See fig. 30.) The tripod-bracing struts form an angle of at least 30° with the centerline of the bridge. The first step is assembly of the bracing strut and strut shoe. The strut-shoe shank is inserted into the end of the bracing strut and fastened with the strut-shoe pin. The strut shoe at the end of the bracing strut then is placed at the point where it will enter the soil, and the upper end of the bracing strut is held against the trestle column to determine where the column-bracing clamp is to be fastened to the column. A column-bracing clamp is clamped firmly to the column, and the strut portion of the clamp is fastened loosely about the bracing strut. This permits the clamp to serve as guide for the strut while the strut is turned by a steel picket inserted into the hole at the end. The strut shoe is screwed into the ground until it reaches a firm footing. (See fig. 34.) The column and strut clamps are loosened and tightened alternately to obtain a firm bearing between column and strut. Finally, the column-bracing clamps are tightened around the bracing strut. Under no circumstances should cross bracing be used between adjacent trestles if there is a possibility of either trestle settling *more than 1 foot.*

(2) *Semistable foundation.* Use one longitudinal diagonal bracing strut in each span. (See fig. 31.)

(3) *Stable foundation.* Use longitudinal cross bracing. Both ends of one brace may be clamped on the outside, and both ends of the second brace on the inside of the columns. (See fig. 32.)

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Figure 34. Screwing bracing strut shoe into ground

d. Trestle-shoe anchor cable. (1) Shoes of end trestles are prevented from slipping by fastening them with wire rope to anchor posts or to holdfasts on shore. When site conditions require, all trestle shoes are so anchored. Wire rope should be used; it stretches less than manila rope and may be tightened with the ratchet chain hoist and cable grips.

(2) To attach the anchor cable, pass one end of the wire rope through the four rings of the trestle shoe, and fasten the free end to the standing part of the line using at least three clips, spaced about 3 inches apart. Pass the other end of the cable around the holdfast or through a snatch block attached to the holdfast, place one cable grip on the free end and one on the standing part of the cable, and connect the two grips with the ratchet chain hoist. Fasten loosely three cable clips in their approximate position. Tighten cable with ratchet chain hoist. Tighten cable clips. Remove ratchet chain hoist and cable grips. (See fig. 35.)

e. Maintenance of trestle bracing. See section VIII.

23. DECKING a. Balk. (1) *Normal construction.* In the normal bridge there are eight balk per span, not including siderails. The outside balk in each span are lashed to the cleats on each transom. (See fig. 36.) Two men carry a balk. Outside balk are laid first, to space the trestle in erection. After the trestle is in position the remaining balk are laid.

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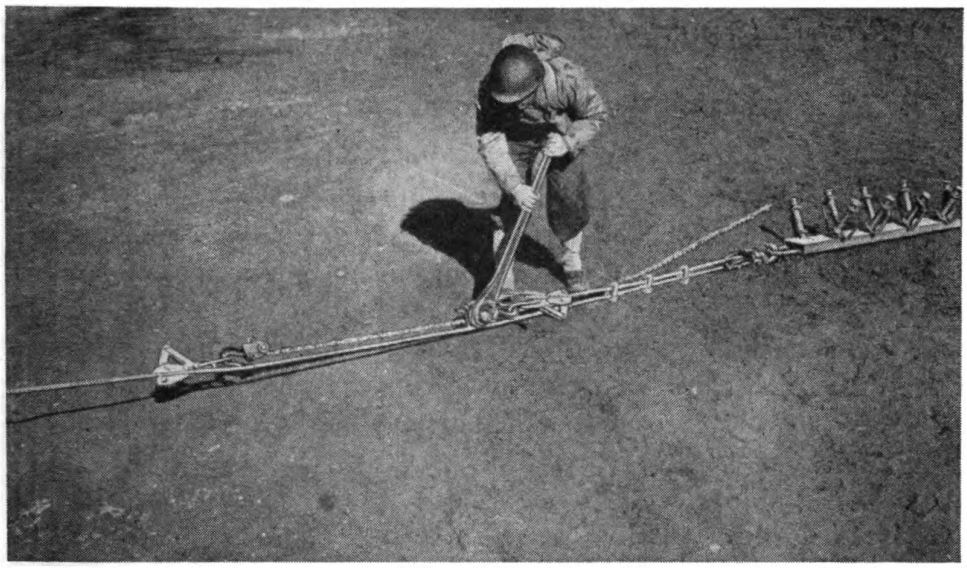

Figure 35. Tightening trestle-shoe anchor cable

In deep-water trestles erected by raft it may be necessary to slide out balk, bottom side up, along balk already in place, to personnel on the raft who place the far ends of the balk on the transom.

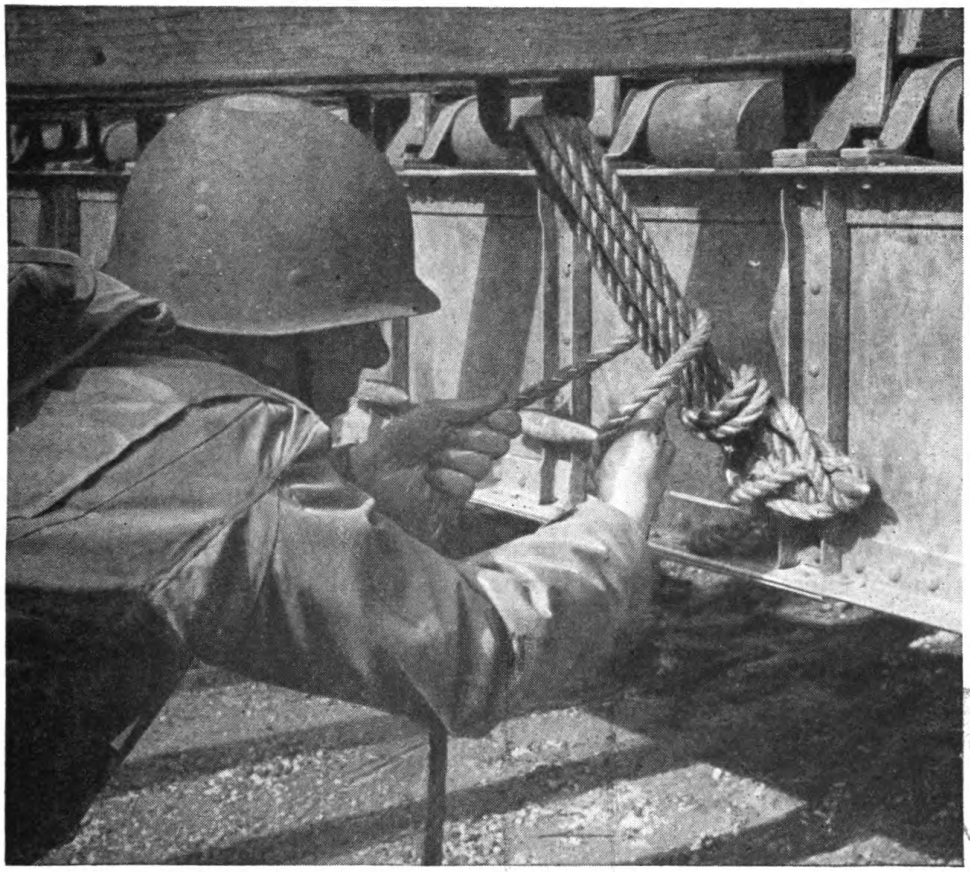

Figure 36. Lashing outside balk to transom

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(2) *Reinforced construction.* In the reinforced bridge there are 14 balk per span, not including siderails, the 6 pairs of extra balk being laid in the spaces between the balk of the normal bridge (center space not used).

b. Chess. There are 15 chess per span. Half-chess are used to fill gaps and to cover joints above trestle transoms. Chess are placed with score marks uppermost and alined along the line between outside pairs of balk. Each span is floored to within 1 foot of the last trestle, to permit placing shore ends of the last span of balk. Two men lay chess, standing on outer pairs of balk and receiving chess delivered by carriers (1 per chess) who approach in single file on the right-hand side of the bridge. (See fig. 37.)

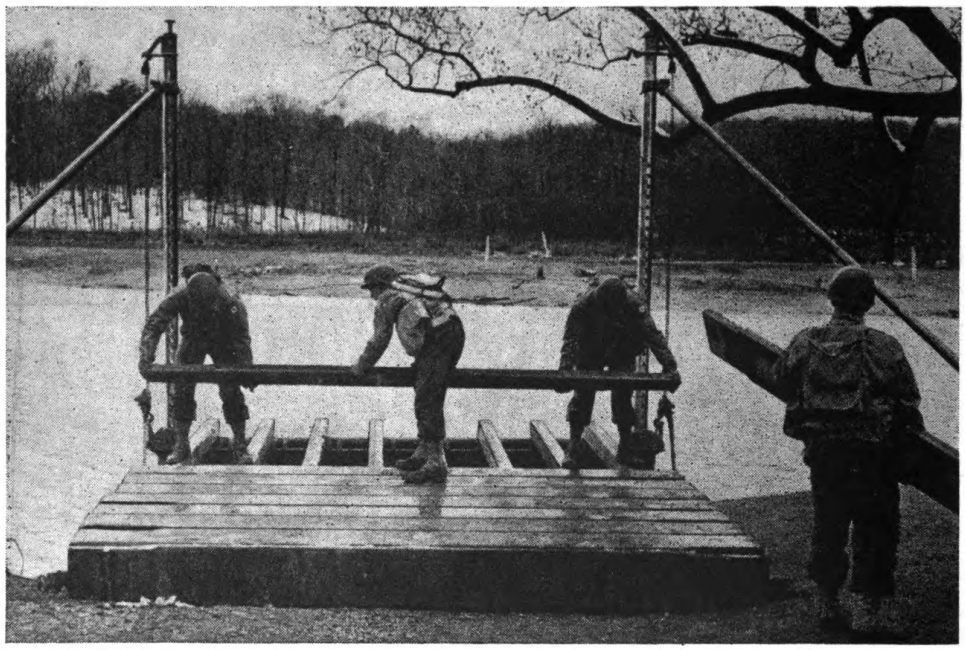

Figure 37. Laying chess

c. Siderails. Siderails are placed and clamped one bay behind the laying of chess. Two siderail clamps per siderail are placed, with screw part upright, at third-points of each span. (See fig. 38.)

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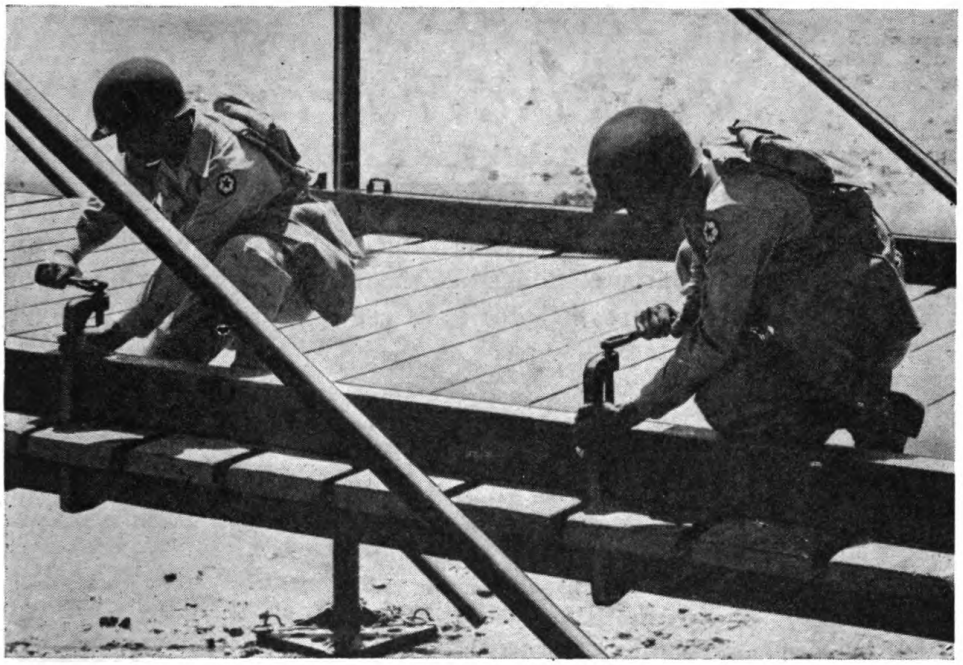

Figure 38. Placing siderail clamps

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SECTION VI

WORKING PARTY

24. ORGANIZATION. The following table gives a suggested organization of a working party to construct the 10-ton trestle bridge. For lists of equipment and detailed duties of sections, see paragraphs 25 to 28, inclusive.

Section	Duties	
	Bridge with one or more deep-water trestles	Bridge with no deep-water trestles
Abutment: 1 NCO, 6 men	Install near- and far-bank abutments. Assist in erecting end trestles and bracing. Adjust bracing on all trestles. Carry and place siderails and fasten siderail clamps.	Same.
First trestle: 1 NCO, 10 men	Assemble and erect first shallow-water trestle and bracing.[1] Assemble third and succeeding trestles on raft. Carry bracing for each trestle.	Assemble and erect odd-numbered trestles.
Second trestle: 1 NCO, 10 men	Assemble and erect second shallow-water trestle.[2] Erect third and succeeding trestles. Erect bracing on all but first trestle.[3]	Assemble and erect even-numbered trestles.
Carrying:[4] 1 NCO, 14 men	1 NCO and 14 men: Construct raft for ferrying trestles. 1 NCO and 8 men: Carry and place balk and chess.[4] 6 men: Ferry first deep-water and succeeding trestles and equipment for far abutment.	1 NCO and 8 men: Carry and place balk, chess, and siderails; fasten siderail clamp.[4] 6 men: Erect bracing on all but first trestle.
Total: 4 NCO, 40 men.		

[1] If first trestle is a deep-water trestle, section immediately starts assembling trestles on raft.
[2] If second trestle is a deep-water trestle, section assembles it on raft.
[3] Other sections finishing work assist in erecting trestle bracing.
[4] If bridge is longer than 75 feet, men must be added to carrying section.

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25. ABUTMENT SECTION (NCO, 6 men)

Bridge with one or more deep-water trestles	Bridge with no deep-water trestles
DUTIES	
Install near- and far-bank abutments. Assist in erecting end trestles and bracing. Adjust bracing on all trestles. Carry and place siderails and fasten siderail clamps.	Same.
EQUIPMENT	
Per abutment: 1 abutment sill. 2 chess (for end dam). 13 pickets. 1 lashing (for squaring sill). Sledges, picks, shovels. *Trestle bracing:* ½-inch wire rope with cable clips (for trestle-shoe anchor lines). Tools to adjust bracing. *Siderails per span:* 2 trestle balk. 4 siderail clamps.	Same.
PROCEDURE	
Abutments: Square sill on center line of bridge, and level bed for sill and end dam. Drive 11 pickets to hold sill in place (9 on far-bank face of sill, 1 near each end of near-bank face). After abutment-span balk are in place, set end dam (1 chess) on edge with top flush with floor, and drive 2 pickets to hold in place (1 near each end of near-bank face). Backfill approach and tamp to level of 1 inch above surface of flooring. *Trestle bracing:* Assist in erecting end trestle. Install anchor posts and trestle-shoe anchor lines of end trestles; assist in erection of end bracing struts. Adjust bracing on all trestles. *Siderails:* After completion of near-bank abutment, end trestle, and end bracing, section carries and places siderails (trestle balk) and fastens siderail clamps until position of far-bank abutment is determined. Remaining siderails are installed after completion of far-bank abutment.	Same.

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26. FIRST TRESTLE SECTION (1 NCO, 10 men)

Bridge with one or more deep-water trestles	Bridge with no deep-water trestles
DUTIES	
Assemble and erect first shallow-water trestle and bracing. Assemble third and succeeding trestles and far-abutment equipment on raft. Carry bracing for third and succeeding trestles while trestle is being ferried.	Carry, assemble, and erect odd-numbered trestles.
EQUIPMENT	
First trestle: 1 trestle complete with 2 chain hoists, bracing, and guy lines (if used). 2 trestle balk (to assemble trestle on). 4 lashings (for outside balk). Tools (as required for footings). *Third and succeeding trestles:* Trestles, complete with chain hoists and guy lines (loaded on raft). *Far-abutment equipment* (loaded on raft): See paragraph 25.	*Per trestle:* 1 trestle complete with 2 chain hoists. 4 lashings (for outside balk). 2 bracing struts with column clamps or 4 guy lines (for erection). 2 trestle balk (to assemble trestle on, then placed in span). Tools (as required for footings).
PROCEDURE	
First trestle:[1] Carry equipment to site. Lay transom on its side on 2 trestle balk, insert columns, attach shoes, attach chain hoists, and attach 2 guy lines (or bracing strut) to each column. (*Note:* If bracing strut is used, tighten clamp to snug fit, but leave free to turn about column to prevent shearing connection bolt during erection of trestle.) Erect trestle, using guy lines (or bracing struts) to guide trestle.[2] Lay outside balk. Aline trestle on center line of bridge. Complete trestle bracing. Lash outside balk to transom. Adjust transom and disengage hoists. *Third and succeeding trestles:* Assemble trestles (2 at a time) on raft. Carry trestle bracing while trestles are being ferried and erected. Place far-bank abutment equipment on raft with last trestle.	*First trestle:* Same. *Remaining odd-numbered trestles:* Same as first trestle.

[1] If first trestle is a deep-water trestle, section immediately starts assembling trestles on raft.
[2] See paragraph 20.

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27. SECOND TRESTLE SECTION (1 NCO, 10 men)

Bridge with one or more deep-water trestles	Bridge with no deep-water trestles
DUTIES	
Carry, assemble, and erect second shallow-water trestle. Erect third and succeeding trestles from raft. Erect bracing on all but first trestle.	Carry, assemble, and erect even-numbered trestles.
EQUIPMENT	
Second shallow-water trestle: Same as first shallow-water trestle (par. 26). *Third and succeeding trestles:* See paragraph 26.	Same as for odd-numbered trestles (par. 26).
PROCEDURE	
Second shallow-water trestle:[1] Trestle and bracing erected in same manner as first trestle (par. 26). *Third and succeeding trestles:* When raft is in position at bridge NCO and 4 men board raft, remaining 6 men stay on bridge or shore.[2] Lift trestle to upright position (4 trestle men assisted by raft men of carrying party). Steady trestle with guy lines. (2 raft men on far lines, 2 trestle men on near lines.) Pass 2 outside balk out to raft and engage on transom. Move raft away from bridge until balk engage transom of previously erected trestle. Aline trestle on center line of bridge by maneuvering raft. Drop columns (2 trestle men). Slide out and engage remaining 6 balk. Engage chain hoists and lift transom free of raft, insert transom pins, disconnect chain hoists. (Raft turns around to unload, or returns for next trestle.)[2] Lash outside balk to transom. Erect trestle bracing. Repeat procedure as soon as next trestle is ferried into position. Far-bank shallow-water trestles are unloaded from raft and erected in same manner as near-bank shallow-water trestles.	*Even numbered trestles:* Same as first trestle (par. 26).

[1] If second trestle is a deep-water trestle, section assembles it on raft.

[2] See paragraph 28 for duties of raft men of carrying section.

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28. CARRYING SECTION (1 NCO, 14 men)

Bridge with one or more deep-water trestles	Bridge with no deep-water trestles

DUTIES

Construct raft for ferrying trestles and far-bank equipment. Ferry first deep-water trestle, succeeding trestles, and far-bank abutment equipment (6 men). Carry and place balk and chess (NCO and 8 men).[1]	Carry and place balk, chess, and siderails; fasten siderail clamps (1 NCO and 8 men).[1] Erect trestle bracing on all but first trestle (6 men).

EQUIPMENT

10-ton ponton raft 2 pontons 3 ponton balk 6 chess 4 stirrups 2 anchors with anchor lines (or guy lines) 6 oars 2 lashings	*Pneumatic raft* 2 floats (12-ton) 7 ponton balk 2 trestle balk 6 float transoms 4 chess 8 siderail clamps 2 guy lines 4 lashings 6 paddles	*Bridge deck:* 8 trestle balk per span. 15 siderails (trestle balk) per span. 4 siderail clamps per span *Trestle bracing:* As required by character of foundation.
Bridge deck: 8 trestle balk per span. 15 chess per span.		

PROCEDURE

Raft construction (NCO and 14 men): Construct raft for ferrying trestles and far-bank abutment equipment (see par. 20). *Laying bridge deck* (NCO and 8 men): Carry balk to bridge; place balk on transoms of shallow-water trestles only (second trestle section places balk on deep-water trestles). Carry and lay chess. *Ferrying trestles* (6 men):[2] Move raft to head of bridge. Drop anchors, if used; or pass guy lines to trestle men on shore or bridge. Assist trestle men to lift trestle upright. Aline raft as directed. Turn raft around to unload next trestle, or return for new load. Repeat procedure for remaining deep-water trestles; assist unloading of far-bank shallow-water trestles and far-abutment equipment.	

[1] Add men to carrying section if bridge is longer than 75 feet.

[2] See paragraph 27 for duties of second trestle section in erecting deep-water trestles.

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SECTION VII

CONSTRUCTION OF LANDING STAGES

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29. GENERAL. For ferries using pneumatic or 10-ton ponton rafts a site for loading onto the raft directly from the banks usually can be prepared by a bulldozer in less time than it takes to construct a landing stage. Where banks cannot be prepared with a bulldozer, or where banks are too high and no bulldozer is available, a landing stage is necessary. Though a floating-type landing stage suffices for light vehicles, a fixed type using 10-ton trestles is preferred, and must be used for heavier vehicles.

30. DESIGN OF TRESTLE TYPE LANDING STAGE a. Multiple-span landing stage. This landing stage (fig. 39) is built with a hinge span and one or more fixed spans. The riverward end of the hinge span is supported by a trestle placed so that the balk protrude 6 to 7 feet beyond it. This trestle carries no live load; it is used only to raise and

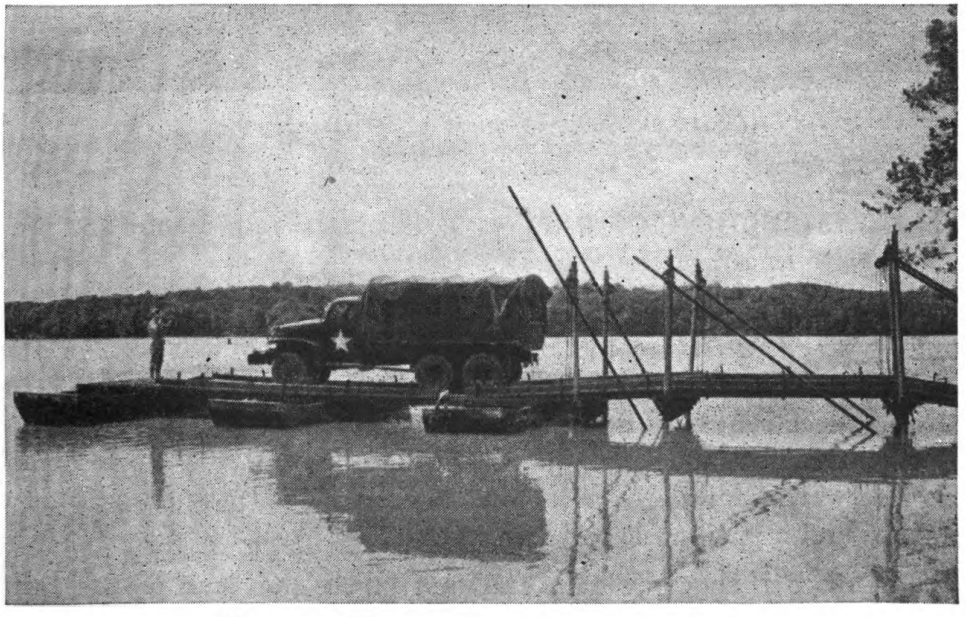

Figure 39. Multiple-span landing stage; loading truck on 10-ton ponton raft

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lower the hinge span. Each balk is secured to the transom by a detachable stirrup and a lashing. Shoreward ends of balk are attached in the normal manner to the transom of the adjacent trestle. The number and position of the balk in the landing stage match those of the rafts. Chess and siderails are placed in the hinge span in the usual manner. Two siderail clamps are placed on each siderail on the shoreward side of the supporting trestle. Either guy lines or trestle bracing (fig. 39) may be used to hold the trestle in position. Chain hoists are used to raise and lower the transom.

b. Single-span landing stage. Where deep water is within 15 feet of a bank seat, fixed trestle spans may be eliminated and a single hinge span supported directly on the abutment sill may be used. If the raft can come within 7 feet of the shore, trestle balk may be used; otherwise, ponton balk must be substituted for trestle balk. (See fig. 40.)

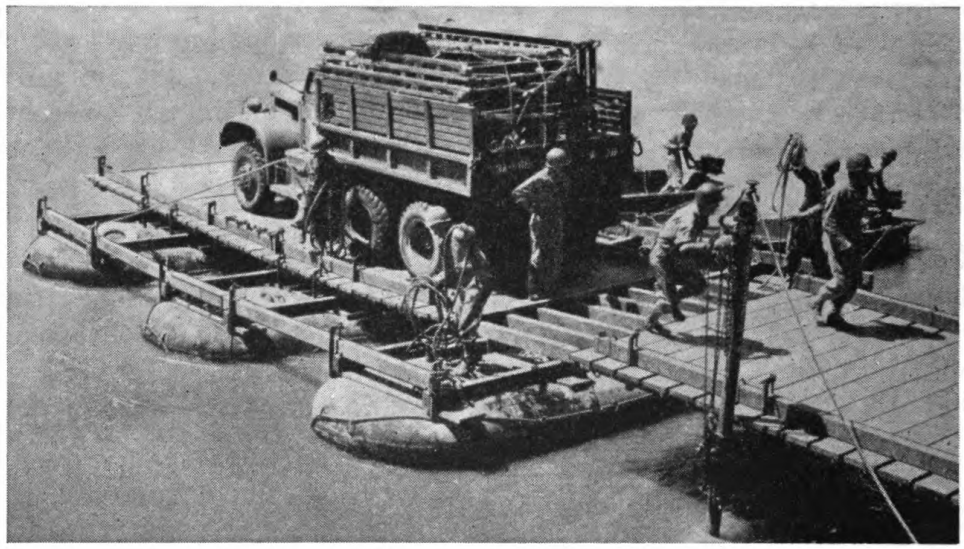

Figure 40. Single-span loading stage; unloading truck from pneumatic raft

31. CONSTRUCTION OF RAFT a. Balk on the raft should not project beyond its sides.

b. Decking is stripped off far enough to allow the trestle balk of the landing stage to engage the riverward gunwale (or float sill) of the shoreward ponton. If the freeboard of the shoreward ponton or float permits, deck space on the raft may be saved by supporting the riverward ends of the hinge span on a hinge sill placed on the shore side of the riverward gunwale (or float sill). A trestle balk may be used as a hinge sill on a pneumatic raft (fig. 41).

c. If more than eight balk are used under the deck of the raft, reduced clearance between interlocking balk makes it difficult to guide the raft into position.

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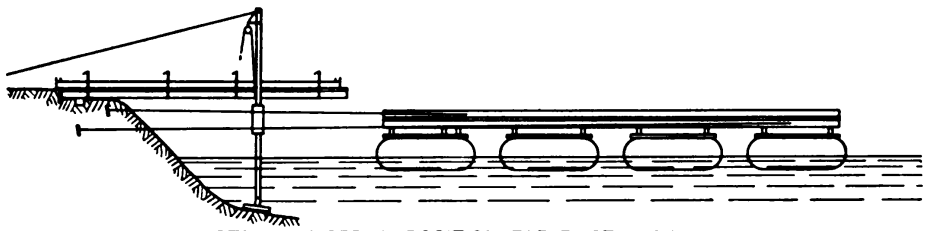
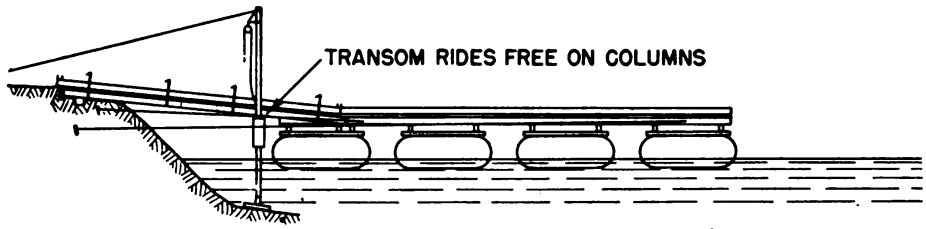
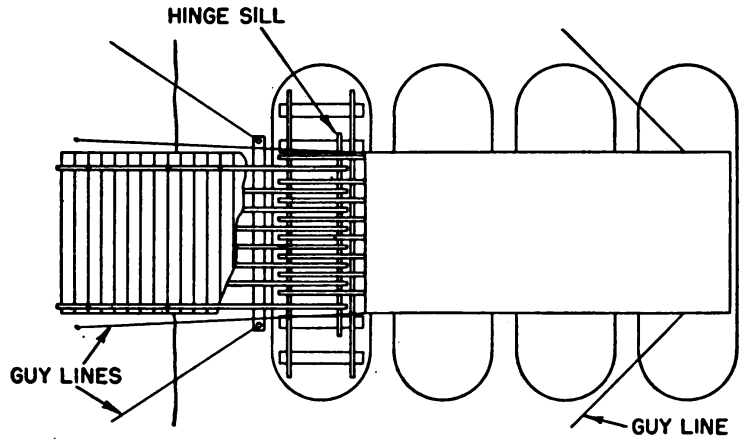
32. OPERATION OF LANDING STAGE. When the raft approaches, the transom is raised enough to allow the shoreward end of the raft to come into position beneath the overhanging portion of the hinge span. The hinge-span transom is lowered until the hinge-span balk rest on the shoreward ponton. Hooks of the chain hoists are disengaged from the transom, which rides free on the columns as the load moves onto the raft. After the raft is loaded, chain hoists are engaged and the transom is raised to permit hinge-span balk to clear the raft, which floats free. (See fig. 41.)



STAGE RAISED IN POSITION FOR RAFT LANDING



STAGE LOWERED FOR LOADING AND UNLOADING RAFT



POSITION OF HINGE SILL AND INTERLOCKING BALK

Figure 41. Operation of landing stage

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33. LOADING AND UNLOADING RAFTS. The approaching raft is guided into position and held in place by guy lines to the shore from both ends of the shoreward and riverward pontons. While vehicles are moving on and off the raft, guy lines are anchored to suitable holdfasts. In a swift current, anchors may supplement guy lines.

34. TIME AND LABOR REQUIREMENTS a. The hinge span of the landing stage can be erected in about 20 minutes by experienced personnel with equipment stacked at the site. One noncommissioned officer and 14 men are required as a working party.

b. At least four men, in addition to the crew operating the ferry, are required to handle chain hoists and guy lines.

c. Rafts can be placed and loaded at the landing stage in about 5 minutes.

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SECTION VIII

TRAFFIC CONTROL AND BRIDGE MAINTENANCE

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35. BRIDGE GUARD. A bridge guard normally is provided. Its duties are as follows:

a. To supervise traffic.

b. To patrol stream to watch for floating mines and other objects that might damage bridge.

c. To repair and maintain bridge.

36. TRAFFIC CONTROL a. Necessity. Traffic control insures prompt passage of important tactical vehicles, diverts vehicles that are too heavy, controls speed and spacing of vehicles, and otherwise expedites movement of traffic and prevents damage to the bridge.

b. Traffic parks. Waiting vehicles are not permitted to block roads. Traffic parks located at intersections of approach roads with main road nets facilitate diversion of vehicles that cannot cross the bridge, and provide cover and concealment for vehicles waiting to cross. While vehicles are parked, drivers are instructed as to speed and vehicle spacing when crossing the bridge.

c. Traffic posts. Guards are posted at each end of the bridge and at each traffic park. Additional guards are placed at intervals on long bridges.

d. Capacity of bridge. The bridge guard must know the safe capacity of the bridge. (See table I.) Load limits should be exceeded only in an emergency when all concerned know the risk, and under the following conditions:

(1) All balk sound. This is best indicated by a record of previous use with heavy loads.

(2) All siderail clamps properly placed, and tight.

(3) Vehicles not exceeding *caution* speed (see *e* below).

(4) Vehicles properly spaced for crossing with *caution* (see *f* below).

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e. Speed of vehicles. (1) When the 10-ton trestle bridge is used as a fixed bridge, vehicles should not exceed the following speeds:

(*a*) When crossing is *safe* (table I), 25 miles per hour for light vehicles, 15 miles per hour for heavy vehicles.

(*b*) When crossing with caution (table I), 5 miles per hour.

(2) If the bridge is used in combination with a floating bridge, vehicles must not exceed the speeds established for floating bridges. Clear width of roadway is 118 inches. If clearance of wheels or tracks is less than 8 inches on each side of the vehicle, speed must be reduced, and, if clearance is less than 3 inches, the vehicle should be guided across the bridge.

f. Spacing of vehicles. The minimum interval between vehicles on the bridge is 30 yards. At least 50 yards must be maintained between vehicles crossing with *caution*.

37. BRIDGE MAINTENANCE a. Spare parts. A small supply of spare balk, chess, cordage, trestle bracing, and other materials for repair should be collected near one abutment for immediate use. A larger supply should be available under cover and concealment in the bivouac area.

b. Balk and siderails. These should be inspected frequently for cracks. Siderail clamps should be tightened periodically.

c. Trestle bracing. After the initial settlement of trestles, and periodically when the bridge is in use, column-bracing clamps should be loosened and retightened to release stresses introduced in the bracing by movement of the trestles.

d. Trestles. Transoms should be adjusted to allow for small settlements. In case of appreciable settlement, the trestle must be raised from its seat and reset upon a rebuilt foundation and new footings.

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SECTION IX

MAINTENANCE, REPAIR, AND STORAGE OF EQUIPMENT

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38. MAINTENANCE a. General. A regular program of inspection, cleaning, replacement, repair, and painting should be set up and followed. When equipment is stored after extended use it is especially important to inspect it and take corrective measures.

b. Cleaning. Equipment should be thoroughly cleaned before being stored for a considerable period. Metal parts should be kept cleaned and greased, or painted to reduce rusting. Chain hoists in particular should be kept clean to prevent excessive wear and damage to the working parts.

c. Lubrication. In general, mechanical devices are designed to operate satisfactorily without lubrication. Screw parts particularly should not be lubricated, because this leads to accumulation of dirt and dust likely to cause excessive fouling and damage to screw parts. Lubrication of ratchet chain hoists should follow the manufacturer's instructions.

d. Painting. It is essential to keep trestles and wooden parts thoroughly painted. (See par. 39*d* for details.)

39. REPAIRS a. Balk, chess, and sills. In general, repairs to these items are limited to removing crushed or splintered wood, reshaping, painting minor cuts and blemishes, and straightening and refastening metal fixtures. Fittings should be removed from condemned timbers and retained for use as replacements. Minor damages through cuts or abrasions are particularly subject to decay, and should be trimmed and painted as soon as practicable.

b. Fittings. Most repairs to siderail clamps and similar fittings consist of straightening deformations of metal parts and removing burs from threaded parts.

c. Trestles. Slight bends in the transom and columns of a trestle may be straightened in the field. Minor punctures and damage to the

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aluminum trestle may be repaired with a 10-ton ponton repair kit and to the steel trestle with the welding and cutting set. Other repairs generally require facilities of a depot.

d. Painting. (1) *General.* Equipment must be kept painted to prevent corrosion, rusting, or rotting. This is particularly necessary when equipment is stored in the open, or used in salty or brackish water.

(2) *Materials required.* (*a*) Paint, olive drab, lusterless, marked "Paint A." Use for finishing coat. This is a highly water-resistant paint, containing critical materials. Use only for refinishing water-immersible equipment.

(*b*) Primer, rust inhibiting, marked "Paint F–I." Contains critical materials. Use only for repainting steel and aluminum water-immersible equipment.

(*c*) Primer, phenolic, marked "Paint F–II." Use for repainting wooden equipment.

(*d*) Mineral spirits, marked "Paint cleaner and thinner." Use as cleaning agent and thinner. Furnished in 50-gallon drums.

(*e*) Phosphoric acid solvent, marked "Paint etcher—H_3PO_4." Etching agent for repainting aluminum alloy equipment. Furnished in 1-gallon containers. Mix four parts of water with one part of paint etcher before application.

(*f*) Wire brush. Use to remove old paint.

(3) *Repainting aluminum and steel trestles.* Remove loose and cracked paint and other foreign matter from all surfaces with wire brush. Clean by sandblasting, if equipment is available. Remove sand from surfaces before applying paint. In addition to such cleaning, wash surfaces with mineral spirits (paint cleaner and thinner), and rinse in clean, unused, mineral spirits. Next, etch aluminum surfaces with phosphoric acid etching solvent (paint etcher), keeping solution in contact with aluminum surface for 15 minutes; then wash the surface thoroughly with warm water. Apply two coats of primer (Paint F–I) to the trestle (steel or aluminum). Apply one finish coat of paint (Paint A) 24 hours after priming.

(4) *Repainting balk, chess, and other wooden parts.* Clean all loose or cracked paint and other foreign matter off surfaces to be painted, using wire brush. Apply two coats of primer (Paint F–II). Apply one finish coat (Paint A) 24 hours after priming.

(5) *Nonferrous metal surfaces.* Brass, bronze, and other nonferrous metal surfaces (except aluminum) need not be painted, but should be given a dull finish to reduce reflection of light.

(6) *General remarks.* Apply primer within 5 hours after completion of cleaning. Paint should provide a smooth, even surface, suitable for application and adhesion of subsequent coats. Apply by brush or spray. If by spray, dilute each gallon of paint with a quart of mineral spirits (paint cleaner and thinner). Do not apply paint to moist surfaces, nor

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during rainy weather, unless part is protected against effects of weather. Maintain at or above 50° F. the atmosphere in contact with the paint surface. Paint should be at approximately the same temperature as the surface on which it is applied. When painting has commenced, the complete operation, including priming coats and finish coat, should be completed as soon as practicable allowing, however, at least 24 hours between priming and finish coats.

40. STORAGE a. General. Always store equipment under cover, when practicable. For open storage, dispose equipment so that water will drain from the stack, ventilation is adequate, and none of the equipment touches the ground. Equipment must be well painted when stored in the open for an extended period.

b. Trestles. Trestle parts may be stored in any convenient fashion, provided care is taken to prevent crush ng or bending of columns and transoms. Preferably, the transom should be placed erect, to avoid possibility of bending or damage to cleats. Trestle shoes may be stacked or laid side by side, teeth down, columns also laid side by side.

c. Ratchet chain hoists. They always should be stored in chests.

d. Balk, chess, and sills. These members should be placed in well-ventilated stacks well off the ground, with one end higher than the other to allow for drainage, if in the open.

e. Fittings. Chests or bags are suitable for storing and transporting siderail clamps and other small metal parts.

f. Miscellaneous items. These include rope and steel pickets. Rope should be coiled, handled, and stored as prescribed in engineer field manuals. Periodically, and before storage, it should be washed thoroughly to free it of grit and dirt.

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APPENDIX

LIST OF EQUIPMENT

Item	*Quantity*
Auger, post-hole, 6-inch capacity	1
Balk, trestle, 10-ton	80
Bolt, clamp, column, balk type	6
Chess, ponton, 10-ton	80
Chess, ponton, half, 10-ton	6
Chest, chain-hoist, ratchet	2
Clamp, column-bracing, 10-ton	32
Clamp, siderail, ponton, 10-ton	36
Clip, wire-rope, ½-inch capacity	40
Grip, wire-rope, ½-inch capacity	2
Hoist, chain, ratchet, 1½- to 3-ton	4
Holdfast, complete with nine pickets	2
Nut and handle, assembly, clamp	6
Picket, steel, 1¼- by 36-inch	32
Pin, strut-shoe	19
Post, anchor, 10-ton	4
Shoe, bracing-strut	16
Sill, abutment, 10-ton	2
Strut, bracing	16
Trestle, 10-ton, complete without hoists	4
Trestle parts: pin and chain, transom	4

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